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Depositional Processes and the Distribution of Sedimentary Environments in the Charlotte Harbor Estuarine System

Final Report to:

Florida Department of Environmental Regulation, Office of Coastal Zone Management

Tallahassee, Florida

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ABSTRACT

R and Q mode factor analyses were performed on a comprehensive sedimentologic data set for the Charlotte Harbor estuarine system in order to define the depositional environments and their distribution. Three sedimentologic units were defined from 215 stations using the following variables: % gravel, % sand, % silt, % clay, mean grainsize, sorting, skewness, kurtosis, % inorganic carbon, % organic nitrogen, and % phosphate.

The three sedimentologic units or end members which accounted for 99% of the Q mode variance are: a sandy mud-fluvial/upper estuarine unit, a slightly muddy/shelley, estuarine/lagoon unit, and a sandy shell hash, inlet/channel unit. Sub-units within the inlet/channel unit are: a sandy tidal delta sub-unit, a shelley muddy channel sub-unit, and a shell dominated channel sub-unit. A sandy lagoon sub-unit was recognized from the estuarine/lagoon unit.

Four factors derived from the R mode analysis acccunted for 83% of the total variance (R mode). Factor 1 has high loadings on parameters of fine grained deposition (silt, clay, organic C/N, sand (-), and sorting) and is interpreted as modeling the low velocity residual currents derived from estuarine mixing and tidal exchange. Factor 2 has high loadings on parameters of coarse grained deposition and is enhanced in the vicinity of the tidal inlets. This factor is interpreted as modeling the high velocity tidal currents that are accelerated by constriction in the inlets. Factor 3 with high loadings on skewness and kutosis does not present sufficient information to attribute to a specific process but may reflect wave activity along shorelines and shoals, biologic (vs. hydraulic) deposition of mollusc shells, or aperiodic storm/high energy events. Factor 4 has a high loading on only one variable, % phosphate, and thus reflects only the distribution of that variable. The phosphate concentration is high in the upper harbor and Peace River and in the tidal channels of the lower harbor.

Comparison of mid-1960's data with early 1980's data shows similar depositional units with an increased area of fine grained "fluvial" deposition, although these changes cannot be isolated from variation due to differences in variables measured and sample density. Deposition rates calculated from ^{14}C dates (6 cm/100 years) are too low to permit discrimination of depositional alterations over the 20 years between old and new data.

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INTRODUCTION

Goals and Objectives

The primary goal of this project is to define and delineate the sedimentary environments and depositional processes of the Charlotte Harbor estuarine system. This goal will be achieved by re-analyzing and synthesizing data from other studies that had more specific objectives (Huang, 1966; Grace, 1977; Pierce et al, 1982; Hine and Evans, 1986; Estevez, 1986). The methods and conclusions of those studies are briefly reviewed and the data incorporated as appropriate. The rationale for assembling and synthesizing the sedimentologic data of Charlotte Harbor lies in the utility of that data for interpreting and temporally integrating biological and physical processes. Because of the disjunct and independent nature of the previous studies, the value of those investigations and the resulting data have never been realized.

The specific objectives of this study are:

1) to assemble and summarize relevant data and previous studies,

2) to re-analyze the comprehensive data set of Huang (1966) to define and delineate the sedimentary environments and controlling depositional processes,

3) to integrate newer, more limited data sets with the old, comprehensive data of Huang (1966) to assess recent alterations,

4) present the sedimentologic data and resulting environmental interpretations in an understandable format for resource managers and planners with non-geologic backgrounds.

STUDY AREA

Climate

The climate of southwestern Florida is humid and subtropical with long, wet summers (75% of 127 cm annual average precipitation June to October) and relatively drier, cooler winters. Temperatures average 34.4 C with maximums of 30.5 C (January) and 38.0 C (July-August) at Punta Gorda (Estevez, in prep.). Prevailing winds are from the northeast during the winter and late spring (November-March) and from the south to southeast during the remainder of the year. Hurricanes and tropical storms are common from June to November with a 50% probability in any year (Ho and Tracey, 1975). Five direct and 24 indirect hurricanes have affected the area since 1900 (Estevez, 1986).

Physiography and Bathymetry

The Charlotte Harbor estuarine system occupies an area of 725 km^2 on the southwest coast of peninsular Florida (Figure 1). The Harbor is a complex estuary composed of two lagoons (Pine Island and Gasparilla Sounds), the estuary proper (Charlotte Harbor), an intra-estuarine lagoon (Matlacha Pass) and the tidal portions of the three tributary rivers

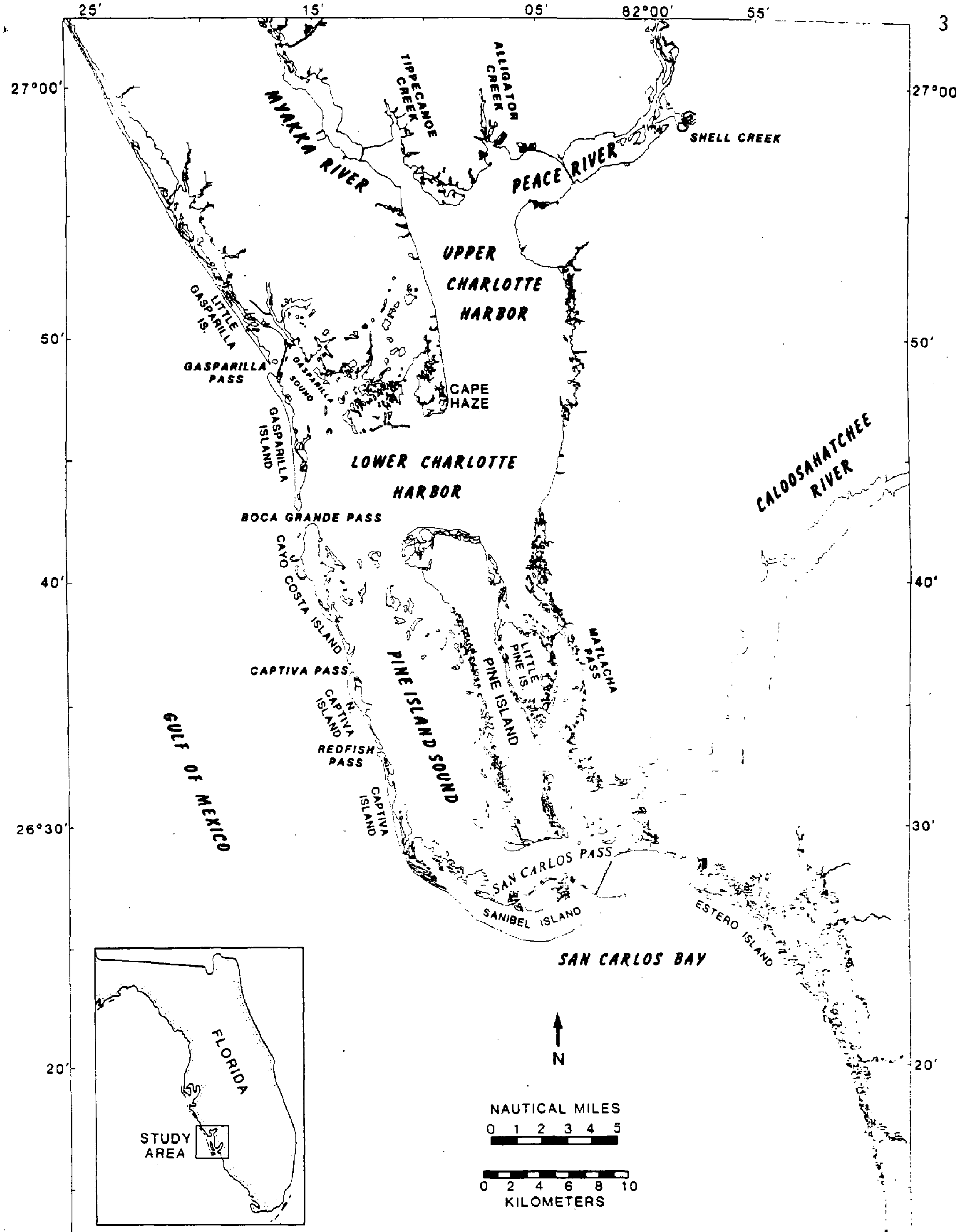


Figure 1. Study area and location map, Charlotte Harbor estuarine system, southwest Florida.

(Myakka, Peace and Caloosahatchee; Figure 1). The average depth of the system is approximately 2.3 m, however the depth of each component varies (Figure 2). Huang and Goodell (1967) have divided the system into 4 bathymetric zones: 1) The broad shallow Harbor with deep narrow channels, 2) Shallow lagoons with extensive sand/seagrass flats from 0-2 m. 3) Slopes adjacent to the primary to the primary tidal channels with depths between 2-4 m, and 4) Tidal channels with depths greater than 4 m (to a maximum of 17 m in Boca Grande Pass; Figure 2).

The combined drainage basins of the Myakka/Peace Rivers and numerous coastal creeks occupy an area of about 8500 km^2 (Figure 3). The basin of the Caloosahatchee River (excluding Lake Okeechobee and its tributaries) covers approximately 3300 km^2 (Figure 3). Topographic elevations within the collective basins are low, averaging 5.5m in Sarasota County, 0.9m in Charlotte County, 2.1m in Lee County, and 17.1m in DeSoto County (Estevez, in prep.).

Hydrology

Discharges of the tributary rivers correlate closely with rainfall, with the highest flows during the rainy season in late summer and early fall. High flow conditions produce vertical stratification in the estuaries with saline bottom waters reaching 8-15 km upstream (Taylor, 1974; Stoker, 1985). Average discharge of the Myakka River is 7.2m^3/sec and includes several periods of no-flow during each year. Two dams on the river affect flow during annual drought conditions and probably contribute to the number of no-flow occurrences (Stoker, 1985). The maximum recorded discharge is 246 m^3/sec with flows greater than 85

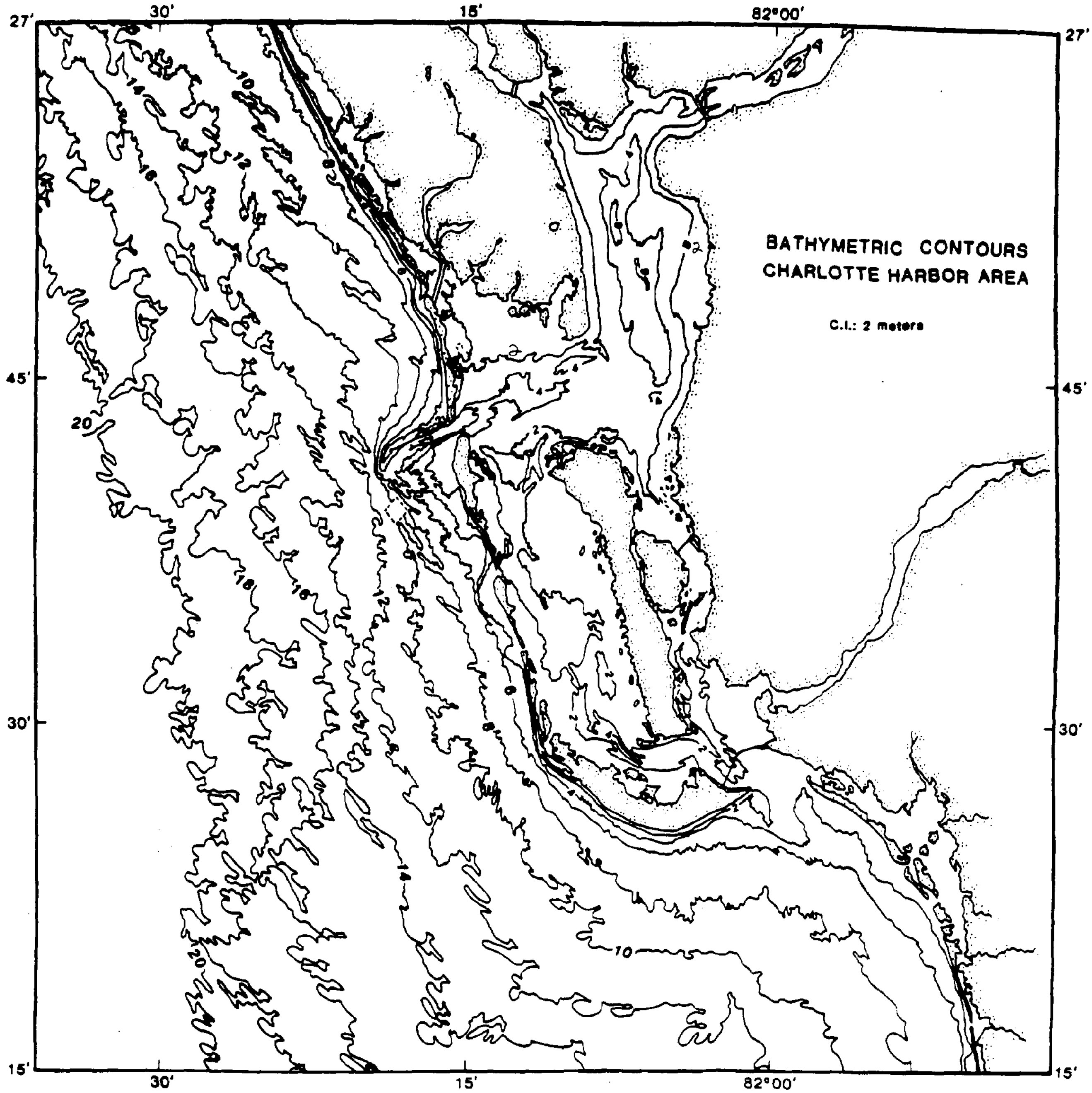
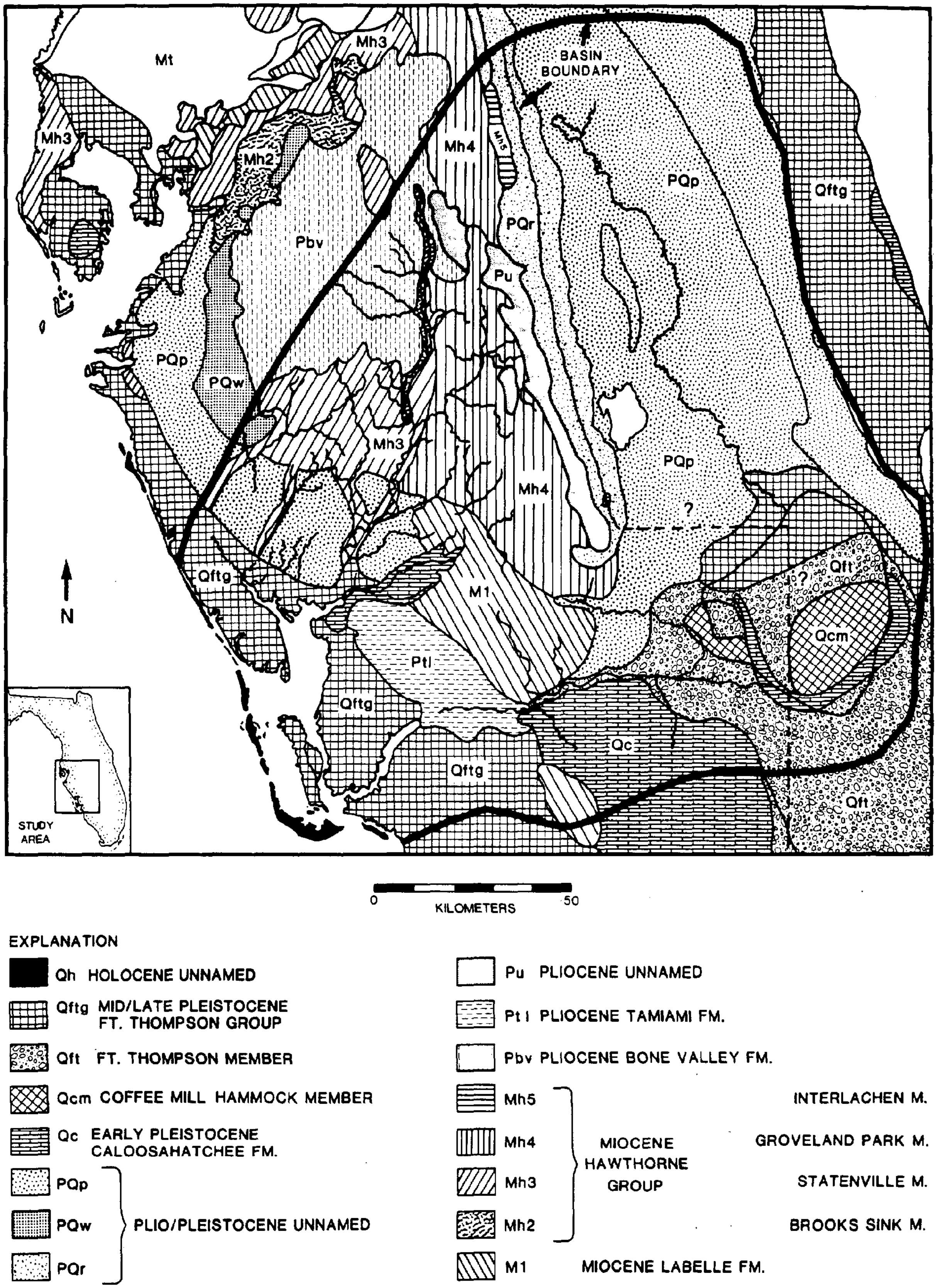


Figure 2. Bathymetric map, Charlotte Harbor region.



REDRAWN FROM BROOKS, 1981

Figure 3. Drainage basin and surficial geology of the Charlotte system.

m^3/sec accounting for 1% of occurences (Estevez, in prep.). Average discharge of the Peace River is 327 m^3/sec with recorded ranges of 1.1 to 1030 m^3/sec. A dam on Shell Creek, a large tributary of the Peace River may affect discharge of the lowermost portions of the River (Stoker, 1985). The Caloosahatchee River is controlled by a series of locks and gates designed to minimize flooding of Lake Okeechobee. Average discharge of the Caloosahatchee is 40.8 m^3/sec and ranges from 0.04 to 606 m^3/sec (Estevez, in prep.).

The estuarine system is separated from the Gulf of Mexico by a series of barrier islands (Gasparilla, Cayo Costa, North Captiva, Captiva and Sanibel; north to south, respectively, Figure 1). Tidal exchange occurs at the intervening inlets (Gasparilla, Boca Grande, Captiva, Redfish and San Carlos Passes, north to south respectively: Figure 1). Primary tidal exchange occurs at Boca Grande and San Carlos Passes with the other inlets having only localized hydraulic exchange (Huang, 1966).

The tides are mixed diurnal/semi-diurnal with a variable range which averages 56 cm at Boca Grande to 79 cm at San Carlos Pass (NOAA, 1985). Maximum flood tide at San Carlos precedes that at Boca Grande by about 15 minutes, which combined with freshwater discharge and wind stress creates a pattern of residual currents throughout the estuarine system.

Tidal currents at the inlets are variable with flood dominated velocities at Boca Grande (120/98 cm/sec; flood/ebb) and San Carlos (54/48 cm/sec; flood/ebb; Coast and Geodetic Survey, Chart #856-C). Captiva Pass, which is located between Cayo Costa and North Captiva Islands, has a flood velocity of 98 cm/sec and an ebb velocity of 102 cm/sec (CGS Chart #856-C). It is not known if the ebb dominated asymmetry of Captiva Pass can be extrapolated to Gasparilla and Redfish

Passes. Ongoing work by the U.S. Geological Survey (Tampa Sub-district) on the hydrography of the estuarine system should provide answers to these questions.

Regional Geology

The stratigraphic nomenclature used to describe the geologic units of Florida is in a state of flux (T. Scott, pers. comm.). Consequently, the names and ages of most of the Neogene and Quaternary units are also changing. However, for the purpose of this discussion, it is the sedimentologic composition of the surficial deposits in the source area that are of primary significance. The surficial deposits of the combined drainage basins are a mixed assemblage of limestones, dolomites, quartz sands and clays that are all of post-Eocene age (Brooks, 1981).

The quartz sands which constitute most of the sedimentologic substrate of the basin are Appalachian in origin and reflect multiple periods of deposition and transport (Huang, 1966; Brooks, 1981). The numerous reworkings of the quartz sands have resulted in a generally homogeneous texture and composition. Unstable heavy minerals have been chemically or physically destroyed and the quartz is present as fine to very fine sand (Huang, 1966). The carbonates (limestone and dolomite) are biogenic and generally represent in situ deposition with complex diagenetic histories. Erosion and transport of the carbonates is limited due to lithification.

Inorganic clay minerals (primarily montmorillonite, kaolinite and palygorskite) are present throughout the basin (Brooks, 1981). The clays are present as areally limited, cohesive beds and disseminated, accessory components. Primary phosphorite (as carbonate-fluoro-apatite) is disseminated throughout the Neogene units and constitutes up to 15% of the total sediment in some deposits. Fluvially reworked phosphate deposits occur as silt to pebble sized clasts which are present in most Charlotte Harbor samples in 1-2% concentrations and up to 9% in some samples (Huang, 1966). The phosphorite is mined and processed in Polk, Hillsborough, Hardee, and Manatee Counties directly in or adjacent to the Charlotte Harbor tributaries.

Figure 3 is a portion of the geologic map of Florida (redrawn from Brooks, 1981). The combined drainage basins contain the following surficial units (from oldest to youngest).

1) Hawthorn Group (Miocene age)

Mh5- Interlachen facies; quartz sand and quartzite gravel with kaolinite clay beds.

Mh4- Groveland Park facies; deeply weathered clay sand and granular sand with kaolinitic clay, white to pale orange with thick paleo-soil (orange/red).

Mh3- Statenville type; sand, silty sand to clay, oyster bars common, mixed montmorillonite/palygorskite clays.

Mh2- Brooks Sink type; impure dolomite, clay and sand.

Ml- Labelle formation (previously called lower Tamiami fm.) clastics and impure limestone, variable phosphorite concentrations, gray to green to tan matrix.

2) Bone valley formation (Pbv; Pliocene age)- sand, clayey fine sand with montmorillonite clays and phosphorite clasts in a greenish matrix.

3) Tamiami formation (Ptl; Pliocene age)- impure clayey to sandy to marly limestone with phosphorite grains, soft to medium hard, tan to gray matrix.

4) Unnamed (Pu; Pliocene age)- undifferentiated quartz sand (fine to very fine) with humate zones, heavy mineral zones and gravel lenses.

5) Unnamed (PQr/PQp; Plio-Pleistocene age)- deeply weathered coarse to fine sand with some clay lenses of beach/dune origin (PQr) and shelley, silty gray to greenish gray sand of lagoonal origin (PQp).

6) Caloosahatchee formation (Qc; early Pleistocene age)- calcareous shelley sand, unconsolidated to indurated.

7) Fort Thompson formation (Qft/Qftg; mid to late Pleistocene) shelley *Chione* sand with multiple hard sandy limestone caps and caliche crusts.

8) Unnamed (Qh; Holocene age)- undifferentiated quartz sand, shell, peat, and clay.

PREVIOUS RESEARCH

A comprehensive mineralogic and textural analysis of the sediments of the Charlotte Harbor system was conducted by Huang (1966) and published as Huang and Goodell (1967). Huang (1966) collected and analyzed 215 surface sediment samples (Figure 4) for textural parameters (% gravel-sand-silt-clay, mean grain size, standard deviation, skewness and kurtosis)) and mineralogic parameters (clay minerals, % phosphate, calcite-aragonite-dolomite, and organic nitrogen/carbon). The results of those analyses were statistically evaluated with a multi-variate non-linear regression technique (trend surface analysis).

Most of this present study is based upon a re-analysis of the data collected by Huang (1966) and a comparison of that data with more recent studies. The conclusions reached by Huang indicate the general relationships between depositional texture/composition, sedimentary provenance, and hydraulic energy. Specifically, Huang concluded that:

1) The sediments have two primary components, quartz sand and biogenic carbonates.

2) Only minor variations in deposition and erosion had occurred in the previous 100 years.

3) The distribution of composition and texture reflects the physicochemical/biological conditions of the system and the controls on distribution are provenance, transportation, depositional environment and to a lesser extent, diagenesis.

4) The mineralogical constituents reflect the availability

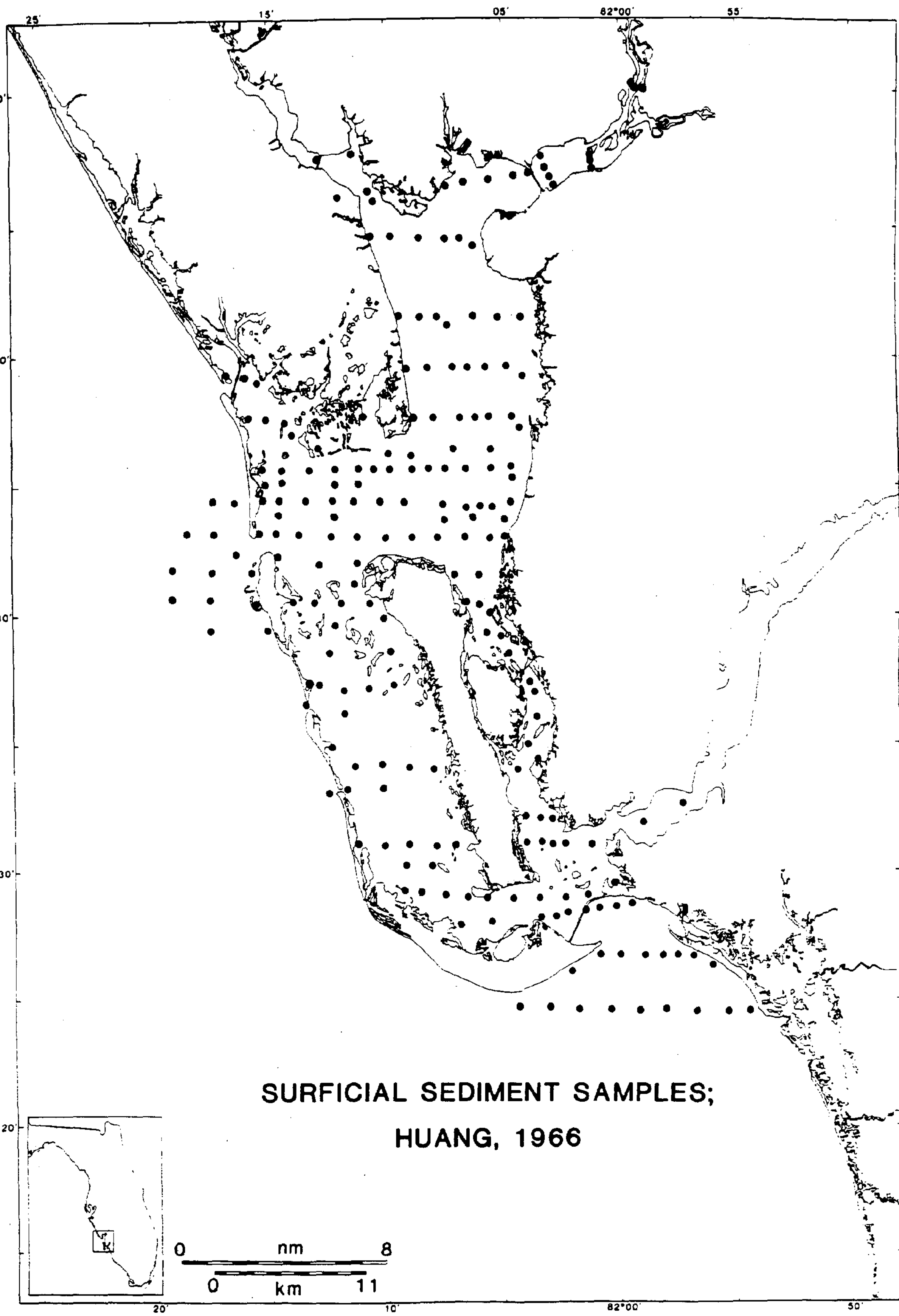


Figure 4. Location of 215 surficial sediment samples collected by Huang (1966).

and proportions of the parent rocks in the source area.

5) Two main tidal circulations occur at Boca Grande and San Carlos Passes with coarser deposits in channel areas and fine deposits in the rivers and harbor head.

6) Mineralogical and textural distributions have predictable channel, slope and sand flat characteristics.

Grace (1977) collected 15, 65cm-long sediment cores from the lowermost Myakka and Peace Rivers. The goal of his study was to quantify the sedimentology of the two systems with respect to the effects of phosphate mining and processing on the Peace River estuary. The parameters used were: acid-soluble iron and phosphorus (total, sand and pan fractions), location, mean phi size, standard deviation, % sand-clay-pan, kurtosis, skewness, % organics, insoluble residue, and salinity/specific conductance (bottom water).

Grace concluded that the rivers are hydrologically similar such that sedimentologic variation would reflect the effects of mining and clay waste effluents on the Peace River. The results are as follows:

1) Mean grain size of Peace River sediments are significantly finer than those of the Myakka River.

2) Phosphorus concentrations are significantly higher in Peace vs. Myakka River sediments.

3) Peace River phosphorus is in the 'pan' fraction and thus finer than the 'sand' fraction phosphorus in the Myakka River.

4) The iron-phosphorus ratio of the Myakka River agrees with general estuarine ratios and the Peace River ratios do not.

All of these results indicate that the Peace River estuary contains significant quantities of fine grained muds with high phosphorus concentrations similar to those associated with clay waste effluent of mining operations. However, fine grained, phosphate-rich sediments also outcrop naturally in the drainage basins. The lower concentrations in the Myakka River estuary might be an artifact of two dams and increased mud deposition in the Upper and Lower Myakka Lakes. In either case, these differences should be considered in subsequent sedimentological analyses.

Pierce, et al (1982) collected 60 surficial sediment samples and 4 cores (3m length; Figure 5) as part of a study designed to assess the hydrocarbons in the Charlotte Harbor system. Most of their report details the nature of the hydrocarbons in sediments and fauna. Although they present grain size data, % organic carbon and summary statistics for the samples, the sedimentological data is otherwise unanalyzed.

Estevez (1986) has studied the infaunal macroinvertebrates of the Charlotte Harbor system, including basic sedimentology at 21 intertidal and subtidal stations. The objectives of the study were:

1) To provide a listing of infaunal macroinvertebrates from soft bottom environments.

2) To assess the suitability of various sampling methods.

3) Identify spatial and seasonal trends in infaunal distributions relative to tidal current patterns, salinity, sediment type or other environmental parameters.

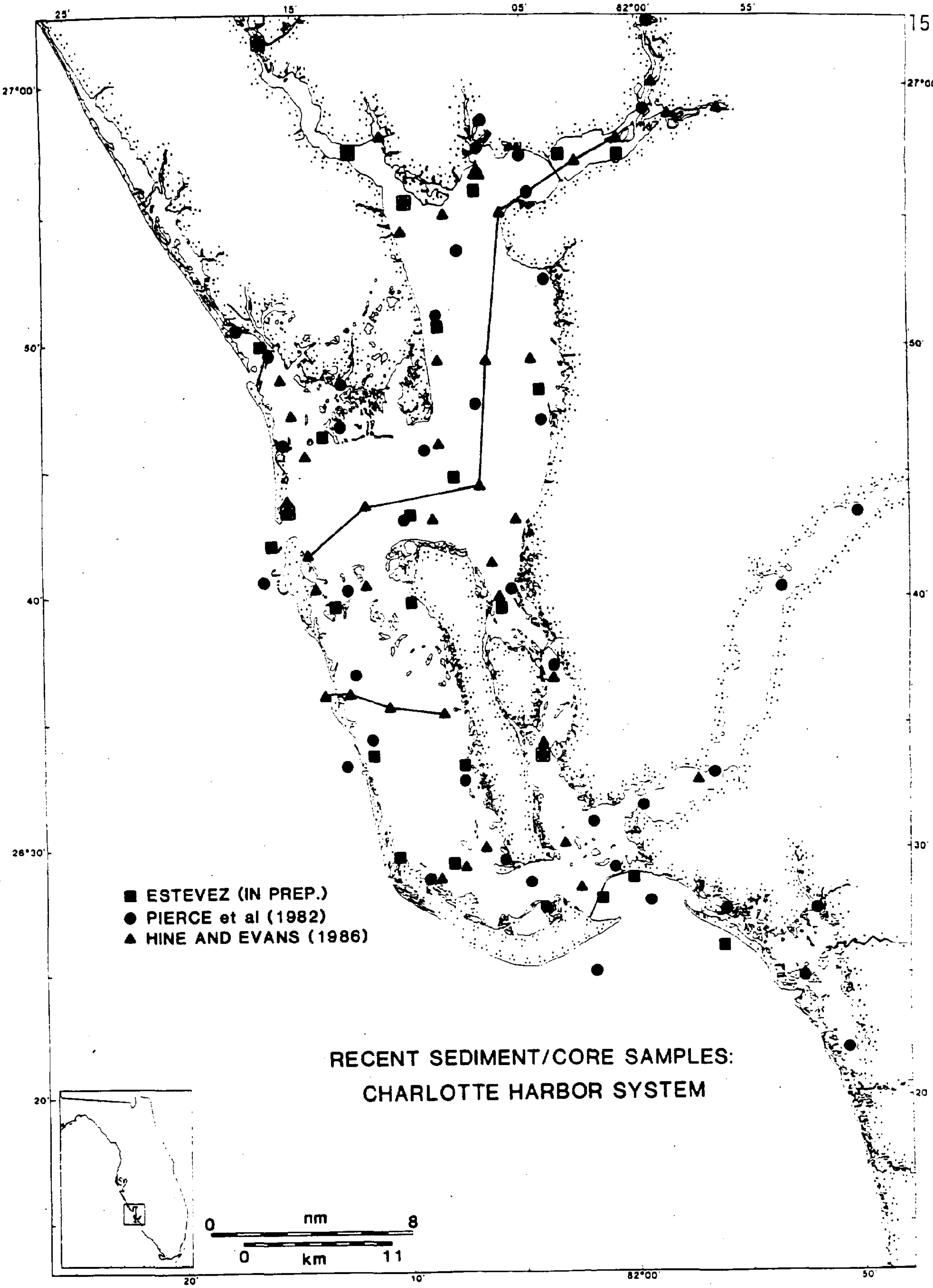


Figure 5. Location of recent sediment samples and vibracores collected by Pierce et al (1982), Hine and Evans (1986) and Estevez (1986).

It is important to note that sampling was restricted to soft, unvegetated bottoms and consequently does not attempt to quantify all of the bottom environments in the Harbor.

Estevez (1986) found that faunal distributions generally corresponded with salinity and dissolved oxygen gradients. He divided the estuarine system into geographic zones and examined faunal assemblages with respect to those zones and environmental parameters. The molluscan, crustacean and polychaete assemblages were analyzed and compared separately. Only the molluscan assemblages showed a clustering between stations that coincided with the geographic zones. The sediments were generally moderately sorted fine sands with medium sands near the inlets. The spatial distribution of species showed no distinct assemblages, rather the various communities are combinations of a broadly dispersed fauna.

Hine and Evans (1986) collected 41 vibracores (82 to 736 cm in length) from throughout the estuarine system (Figure 5). Ten of the cores were subsampled for the following parameters: grain size distributions, % $CaCO_3$, % organic carbon, $d^{13}C$ (PDB standard), and mineralogy (X-ray diffraction). All of the cores were described relative to: color (GSA rock color chart), bedding/structure, bioturbation, macrofossils and visually estimated gravel-sand-mud. The specific objectives of this study were:

1) To define, from vertical profile the sedimentological facies of the harbor system.

2) To derive environmental and paleo-environmental interpretations for the defined facies.

3) To provide stratigraphic control for delineating the Quaternary infilling history of the Harbor system.

The report (Hine and Evans, 1986) contains no conclusions or analyses but does contain all of the data including detailed core logs. The data from those cores will be presented and analyzed with respect to the surface sedimentologic samples in order to provide a 3-dimensional interpretation of the depositional facies.

METHODS

This study is based upon sedimentologic data from a number of existing research projects. The specific techniques utilized in the different studies to obtain the same parameters are slightly different, but usually comparable. In order to make the various data sources comparable and the results of this study interpretable to non-geologists, this section will contain a brief summary of the sedimentologic parameters and their utility in environmental analyses. These summaries will be followed by the statistical methodologies used to analyze the data.

Grain Size Distributions

A grain size distribution is the relative frequency of different size classes of a sediment sample, which is usually presented in a statistical or graphical format (Figure 6). There are four main reasons for doing grain size analyses (Blatt, et al; 1980): 1) Grain size is a

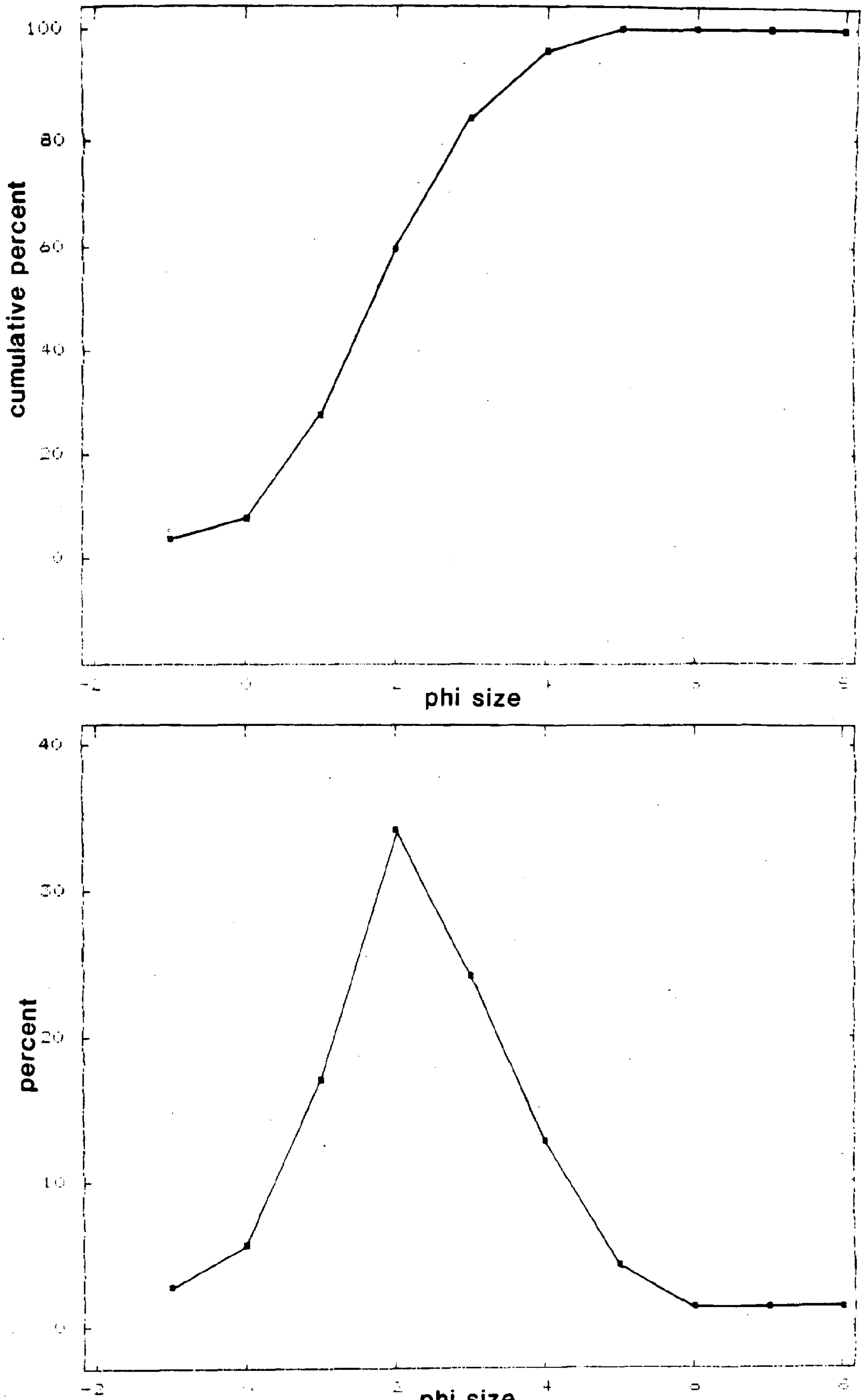


Figure 6. Grain size distribution for hypothetical sediment sample plotted as percent and cumulative percent vs. phi size.

descriptive measure of the sediment which requires some precision in measurement. 2) The distribution of size classes may be characteristic of sediments deposited in certain environments. 3) The study of grain size distributions may lead to basic interpretations of the physical mechanisms acting during transport and deposition. 4) Grain size may be related to other properties such as permeability that can be predicted from grain size data. All of the samples used in this study were analyzed using procedures described by Folk (1980).

The samples were wet-sieved through a 0.063 mm sieve to separate the sand-mud fractions. The sand/gravel fraction was dried and sieved through nested screens at 1 phi intervals (phi size = $-\log_2$[diameter in mm]). The mud fraction was homogenized in 1000ml cylinders and subsampled at various depths and time intervals to obtain the % silt-clay based upon predicted settling velocities (Folk, 1980).

The results of the grain size analyses are initially recorded as weight % in each size class. Interpretation of the raw data requires graphic plotting as frequency or cumulative % vs. phi size (Figure 7), and/or derivation of summary statistics eg. mean grain size, sorting (standard deviation), skewness, and kurtosis. Mean grain size and standard deviation (sorting) are in phi sizes in which larger numbers indicate finer grain size, and are self-explanatory with respect to the size-frequency distribution. Skewness is a measure of the asymmetry of the distribution and kurtosis is a measure of the peakedness of the distribution. Table 1 summarizes the phi scale and representative values of sorting, skewness and kurtosis.

Table 1. Representative values of grain size scales, sorting, skewness and kurtosis (from Folk, 1980).

GRAIN SIZE SCALES

Millimeters	Phi	Wentworth Size Class
4.0	2.0	pebble
2.0	-1.0	granule
1.00	0.0	very coarse sand
0.50	1.0	coarse sand
0.25	2.0	medium sand
0.125	3.0	fine sand
0.0625	4.0	very fine sand
0.0310	5.0	coarse silt
0.0039	8.0	very fine to medium silt
0.0020	9.0	clay

REPRESENTATIVE STANDARD DEVIATION/SORTING VALUES (PHI SCALE)

0.35	very well sorted
0.35 - 0.50	well sorted
0.50 - 0.71	moderately well sorted
0.71 - 1.0	moderately sorted
1.0 - 2.0	poorly sorted
2.0 - 4.0	very poorly sorted
4.0	extremely poorly sorted

REPRESENTATIVE SKEWNESS VALUES (NON-DIMENSIONAL)

-3.0 to -1.0	strongly coarse skewed
-1.0 to -0.10	course skewed
-0.1 to +0.10	near symmetrical
+0.10 to +0.30	fine skewed
+0.30 to +1.0	strongly fine skewed

REPRESENTATIVE KURTOSIS VALUES (NON-DIMENSIONAL)

0.67	very platykurtic
0.67 - 0.90	platykurtic
0.90 - 1.11	mesokurtic
1.11 - 1.50	leptokurtic
1.50 - 3.00	very leptokurtic
3.00	extremely leptokurtic

Sediment Composition

In addition to the parameters describing the size distribution of a sediment sample, various compositional attributes of the sample must be quantified in order to assess the depositional environment. The compositional variables used in this study includes: % organic carbon, % $CaCO_3$, % organic nitrogen, % phosphate, and relative percentages of various clay minerals.

Pierce, et al (1982) and Estevez (in prep.) measured total organic carbon (TOC) by combusting pre-weighed, oven-dried samples at 550°C for 1 hour. TOC was calculated by subtraction of combusted weight from the total weight. Huang (1966) measured TOC and % organic nitrogen in a "Coleman" CHN analyzer which combusts the total sample, and chromatographically separates and measures the constituent gases. Hine and Evans (1986) followed the procedure of Sackett and Thompson (1963). Acid-leached, oven-dried samples are combusted in a flow-through system in the presence of oxygen and the derived CO_2 is manometrically measured. The derived CO_2 was then analyzed in a "Finnegan MAT 250" mass spectrometer to determine the $d^{13}C$ ratio (PDB-standard).

The % phosphate was measured two different ways by Huang (1966) and Grace (1977). Grace used several physical and chemical pre-treatments to transform sedimentary carbonate fluoro-apatite into ortho-phosphate for colorimetric analysis. Specifically, samples were dried, ground and digested in HCl and HF acids. Analyses were conducted on the sand, pan and total fractions. Huang (1966) calculated the % phosphate by comparing the 2.788 ang. phosphate peak and the 2.455 ang. quartz peak of spiked samples on an X-ray diffractometer (XRD). There are several problems with quantifying weight % from XRD data; first, all measurements are only relative to the other peaks (this is partially rectified by spiking each sample with a known quantity of phosphate), secondly, most minerals occur in a solid state transition such that measurement of one mineralogical peak may not detect all of mineral present, and thirdly most of the phosphate in Charlotte Harbor is present as coarse sand to silt and is not amenable to XRD quantification (XRD is most common on the less than 2 micron size range). Huang (1966) also used XRD to estimate the relative proportions of several clay minerals (montmorillonite/kaolinite, palygorskite/kalinite, and zeolite/kaolinite) and carbonate minerals (dolomite/aragonite, and calcite/aragonite). These analyses use the same methods of peak height comparisons and the above limitations also apply.

Total inorganic carbon (biogenic $CaCO_3$) was measured in two ways; Huang (1966) titrated acid-digested samples with EDTA (Turekian, 1956) which measures total calcium, and Hine and Evans (1986) subtracted acid-leached sample weight from total weight and/or used point counting of sand sized particles to separate the quartz-carbonate components.

Statistical Procedures

The primary data base for this study is the comprehensive study of Huang (1966) which measured 18 different sedimentologic parameters over 215 stations. The statistical objectives are to group the 215 stations into a few consistent depositional environments on the basis of the variables, and to group the variables in order to infer process. Of the 18 variables measured by Huang, the 6 variable analyzing clay and carbonate mineralogy were disregarded due to missing cases, infinity ratios, and poor significance on initial analyses.

The statistical procedures used to accomplish these groupings are R and Q mode factor analyses and a Q mode cluster analysis (k-means). R mode analyses group variables on the basis of cases (stations) which can then be used to infer processes. Q mode analyses group cases having similar values on the variables which can be used to define depositional environments.

Factor analysis is a generic term that describes a variety of mathematical procedures applicable to the analysis of data matrices (Klovan, 1975). When only two variables are present a factor can be graphically represented by plotting variable 1 against variable 2. When more than 3 variables are present, the factors cannot be graphically represented and can only be mathematically described as a vector in n-dimensional space (Thorndike, 1978). The cases or samples, represent points in the n-dimensional space and the goal of factor analysis is to describe the distribution of those points using fewer than the original n-dimensions. The factors or components are combinations of the variables (R mode) or samples (Q mode) that describe the distribution of points in n-dimensional space. The factors have no physical meaning, however process can often be inferred by the specific variables comprising each factor and by mapping those areas where each factor is most or least important.

A correlation matrix is the basic input for a factor analysis. The Pearson Product-Moment procedure was used in both the R and Q mode analyses. The Pearson correlation procedure measures similarity between entities on a scale of -1 to +1 using standardized scores that have a mean of 0 and a standard deviation of 1. Optimally, Q mode analyses should use a cosine theta matrix to assess similarities because the Pearson matrix standardizes across variables (Klovan, 1975). Computationally, the two measures are the same except the standardization which only results in subtracting some arbitrary number (the mean of the variables) from each observation.

All of the statistical procedures used in this study were computed on an AT&T 6300 PC using the SYSTAT, Inc. statistical package. The factor analysis procedure is a principal components method with a Pearson correlation matrix. The computed factors were sorted and rotated using a varimax technique (Thorndike, 1978). Output includes factor loadings, factor scores, the initial correlation matrix (R mode only) and eigenvalues. Due to the size of the Q mode analysis (215x215) this analysis was done in two parts with considerable overlap (stations 1-150, and stations 70-215).

A k-means cluster analysis was also used to assess the similarity between stations and verify the groupings established by the Q mode analysis. Cluster analyses are conceptually similar to factor analyses in their use of n-dimensional space to describe the samples. Cluster analysis uses some measure of distance between samples to cluster the samples into groups such that the inter-group distance is maximized and the intra-group distance is minimized (Anderberg, 1973).

The non-hierarchial k-means technique begins with a specified number of clusters (m) which are established from the first m samples. The remaining n-m samples are sorted into the m clusters so as to minimize the intra-cluster variance and the sequence is iterated 30-70 times reassigning the samples before the final clusters are arranged (Anderberg, 1973). The technique requires that the investigator specify the number of clusters, but provides summary statistics for each cluster that may be statistically validated.

Results

The output from the R and Q mode statistical analyses are included in the Appendix. The output includes: the eigenvalues (latent roots), the component loadings and rotated loadings (the relative importance of each factor on each sample, as standard deviations), the factor score coefficients and the initial correlation matrix and factor scores (R mode only).

Three factors representing 3 sedimentologic end members account for more than 99.2% of the total variance of the Q mode analysis. Factor 1 contributed more than 70% of that variance and loadings on this factor were high at almost all stations which indicates the general homogeneity of the sedimentary environments. Factor 2, which accounts for more than 26% of the total variance, has higher loadings than factor 1 at only 38 stations. Loadings on factor 3 exceeded 1 and 2 at only 3 stations.

Three depositional units and two sub-units have been derived from the factor loadings; an estuarine/lagoon unit with 0.400 loadings on factor 2, an inlet/channel unit with loadings 0.400 on factor 2, and a fluvial/upper estuarine unit with loadings 0.400 on factor 3. The sub-units are a tidal delta assemblage from the inlet/channel unit with factor 2 loadings 0.800 and a sandy lagoon unit with factor 1 loadings > 0.950. The distribution of the various units is presented in Figure 7 and summary statistics in Table 2. The summary statistics are from a k-means cluster analysis with essentially analagous station groupings although each unit may differ by a few stations.

Table 2. Summary statistics for sedimentologic units and sub-units calculated from the k-means cluster analysis.

		Fluvial Up/Est Unit	Estuar/ Lagoon Unit	Sandy Lagoon S-Unit	Inlet Channel Unit	Tidal Delta S-Unit	Shell/ Channel S-Unit	Muddy Channel S-Unit
%GRAVEL	mean	5.49	0.67	0.09	7.73	7.31	28.36	4.12
	min	0.00	0.00	0.00	0.00	1.04	10.89	0.00
	max	18.86	7.54	0.95	48.60	16.02	48.60	20.18
	std-dev	7.25	1.42	0.21	5.60	4.18	12.12	5.14
%SAND	mean	47.32	96.17	97.82	85.76	89.43	63.08	88.01
	min	5.10	89.22	95.39	41.01	76.41	41.61	75.88
	max	67.20	100.00	99.63	99.85	97.97	78.41	99.85
	std-dev	19.85	2.91	1.18	6.89	5.73	12.31	6.51
%SILT	mean	28.75	2.41	1.55	4.84	2.63	6.33	5.74
	min	11.72	0.00	0.28	0.00	0.00	0.00	0.00
	max	57.23	7.76	3.59	32.67	11.08	17.98	16.18
	std-dev	12.98	2.04	0.95	4.41	2.28	6.19	4.90
%CLAY	mean	11.77	0.83	0.53	1.62	0.63	2.23	2.04
	min	2.74	0.00	0.00	0.00	0.00	0.00	0.00
	max	28.83	3.96	1.54	10.54	2.54	9.77	9.63
	std-dev	7.72	0.89	0.34	1.80	0.66	3.02	2.18
MEAN	mean	4.12	2.82	2.95	2.10	1.59	0.37	2.69
GRAIN	min	2.16	1.41	2.13	0.31	0.58	-0.84	1.15
SIZE	max	6.03	3.84	3.84	4.68	2.69	1.83	3.84
(phi)	std-dev	1.04	0.38	0.37	0.65	0.52	0.77	0.70
SORT	mean	2.54	1.05	0.82	1.77	1.72	2.42	1.67
(phi)	min	1.55	0.35	0.35	0.62	1.15	1.64	0.62
	max	3.95	1.78	1.11	3.63	2.56	3.55	2.43
	std-dev	0.73	0.29	0.15	0.42	0.37	0.67	0.40
%INORG	mean	22.82	3.26	2.42	43.54	62.96	87.22	16.57
CARBON	min	2.88	0.37	0.37	1.09	40.29	81.23	1.09
	max	48.77	12.54	8.97	93.87	87.45	93.87	33.30
	std-dev	16.42	2.70	2.10	9.34	14.45	4.59	7.49
%ORG	mean	1.91	0.46	0.30	0.79	0.75	1.10	0.75
CARBON	min	0.69	0.04	0.13	0.02	0.28	0.02	0.18
	max	3.06	1.83	0.74	2.74	1.85	1.81	1.74
	std-dev	0.67	0.32	0.13	0.45	0.46	0.60	0.42
%ORG	mean	0.13	0.04	0.03	0.07	0.06	0.14	0.06
N	min	0.07	0.01	0.01	0.01	0.02	0.04	0.01
	max	0.25	0.13	0.09	0.57	0.10	0.57	0.15
	std-dev	0.05	0.02	0.02	----	0.02	0.16	0.03

SKEW	mean	0.18	0.61	1.12	0.20	0.09	0.45	0.22
	min	-0.29	-1.09	-0.18	-1.59	-0.52	-0.13	-1.59
	max	0.63	1.95	1.95	1.60	1.03	0.95	1.60
	std-dev	0.26	0.66	0.51	----	0.40	0.37	0.62
KURT	mean	0.10	9.72	18.04	2.60	1.64	1.11	3.39
	min	-1.10	-0.28	12.86	-1.07	-0.25	-0.83	-0.82
	max	4.07	45.36	45.36	12.85	5.84	4.66	12.85
	std-dev	1.27	5.97	6.41	2.53	1.66	1.92	3.11
%PHOSP	mean	4.15	1.50	1.17	1.76	1.88	0.57	1.92
	min	2.01	0.00	0.00	0.00	0.14	0.00	0.00
	max	6.37	9.03	2.32	7.12	7.12	1.50	4.98
	std-dev	1.52	1.01	0.71	1.16	1.54	0.49	1.08

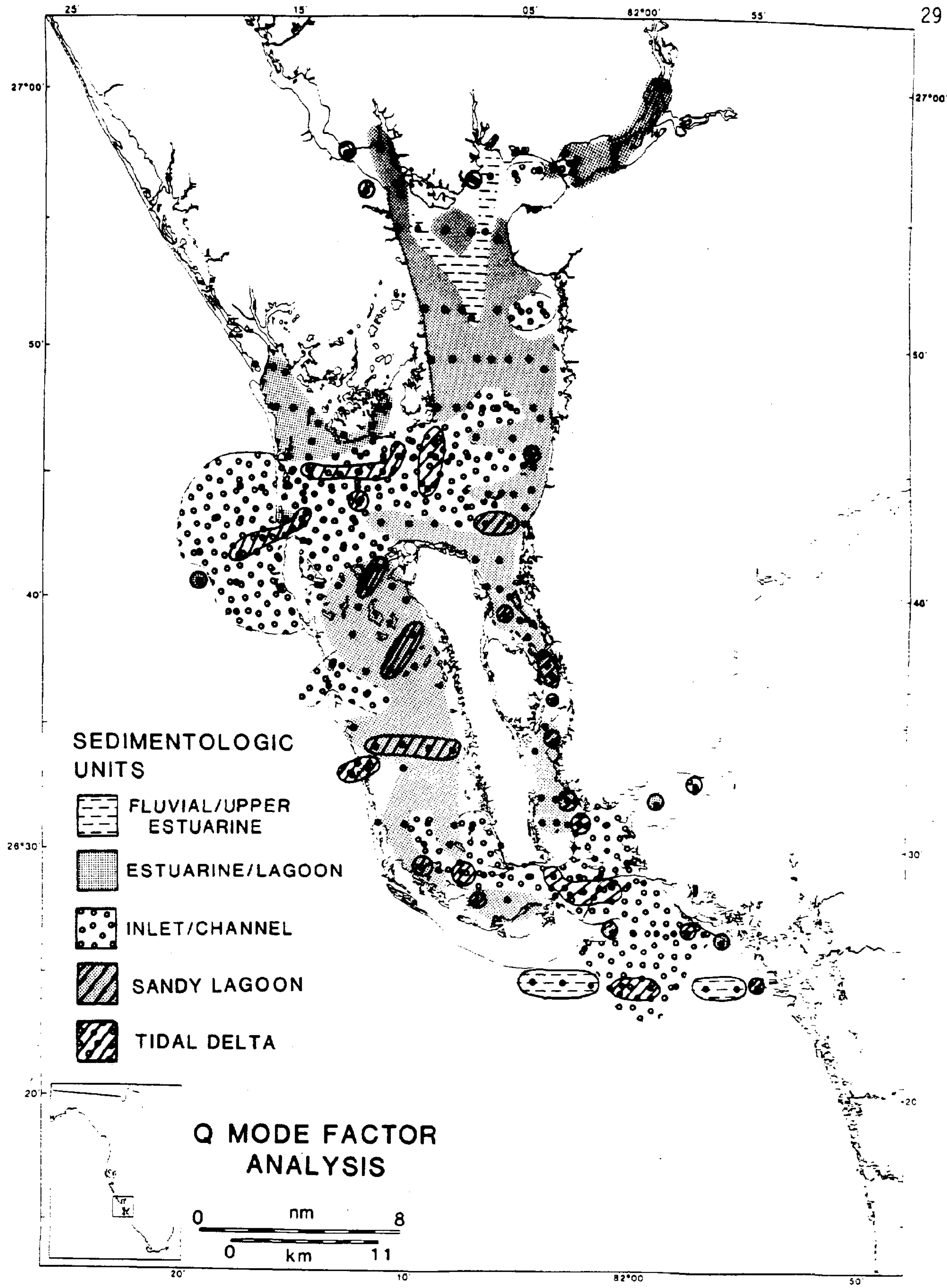


Figure 7. Distribution of sedimentologic units derived from Q mode factor analysis using the data of Huang (1966).

The estuarine/lagoon unit is distributed throughout the Harbor system and comprises 47% of all the stations. The samples are predominately poorly sorted, finely skewed fine sand (2.82phi mean size; 1.05 std-dev.). Organic carbon and nitrogen are moderately low (0.46 and 0.04 %, resp.) and the phosphate averages 1.50%. The fluvial/upper estuarine unit is found at the confluence of the Peace/Myakka Rivers and in San Carlos Bay. This unit is a very poorly sorted coarse silt (2.54 phi std-dev.; 4.12 phi mean size). Consequently, organic carbon and nitrogen and phosphate are all high (1.91, 0.13 and 4.15 %, resp.).

The inlet/channel unit is found adjacent to the tidal passes with most of the samples near Boca Grande Pass and San Carlos Bay (Figure 7). Other samples are located in estuarine and lower fluvial areas and probably associated with elevated currents (i.e., central Matlacha Pass and the El Jobean bridge on the Myakka River). The sediments in this unit are poorly sorted medium sands (2.00 and 1.65 phi, resp.) with 13% shell gravel and 63% inorganic carbon (Table 2).

A tidal delta sub-unit within the inlet/channel unit is also indicated on Figure 7 and Table 2. This sub-unit is located within the central part of the inlet/channel distribution. The sediments of this sub-unit have less gravel, more sand, and less silt-clay than the overall inlet unit. The mean size is slightly coarser but still within the medium sand range. Sorting is somewhat greater than the inlet unit but still in the poorly sorted category. The sub-unit is thus similar, but consistently different than the inlet unit. Likewise, a sandy estuarine/lagoon sub-unit is described that has less mud, less shell-gravel and more sand. The mean grain size is slightly finer than the overall unit due to the lower proportion of coarse shell material but the sub-unit represents a moderately sorted, homogeneous, fine sand, which is located predominantly within central Pine Island Sound.

A preliminary hypothesis of this study was that the sedimentologic data would reveal discrete spatial and environmental trends permitting discrimination between geographic or physiographic entities (i.e., lagoon, upper estuary, etc.). The depositional units defined by Table 2 and Figure 7 represent sedimentologic end members. The specific boundaries separating those units are arbitrary, although well defined both spatially and statistically. Cluster analyses were performed on the data set to examine any spatial trends within the large estuarine/lagoon and inlet/channel units. The output from the 8 cluster analysis is included in the Appendix, and the results summarized in Figure 8.

Comparison of Figures 7 and 8 shows that the inlet unit of Figure 7 has been subdivided into 3 sub-units in Figure 8 (clusters 1, 2 and 4). These 3 sub-units have significantly different values of sand, gravel/inorganic carbon, and silt/clay. Thus the inlet unit may be subdivided along the same 3-way continuum as the entire estuarine system. The estuarine unit of Figure 7 has been subdivided into two sub-units in Figure 8. This unit which has overall low values of gravel and inorganic carbon (0.67 and 3.26%, resp.; Table 2) is subdivided into muddy and sandy sub-units with most of the sandy samples located in Pine Island Sound and along the shoals and shorelines of the Harbor (Figure 8; Table 2). The sub-units defined from the factor analysis (Figure 7; tidal delta and sandy lagoon) are almost exactly analogous to those of the cluster analysis (clusters 2 and 7, resp.).

The processes responsible for the distribution of sedimentary units or environments are examined in the R mode factor analysis (Appendix).

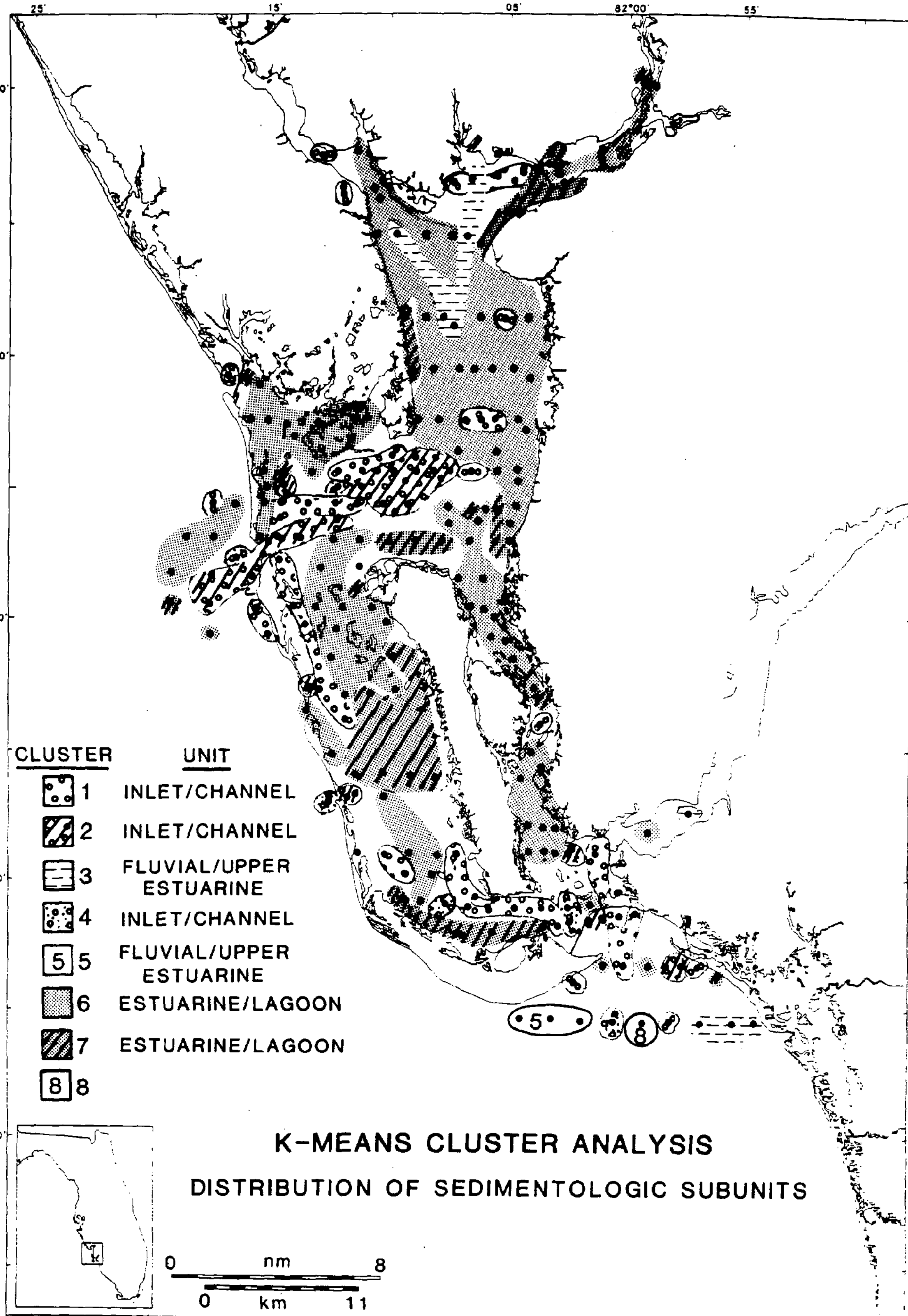


Figure 8. Distribution of sedimentologic units and sub-units derived from k-means cluster analysis using the data of Huang (1966).

The rotated component loadings from that analysis are presented as Table 3. Four factors account for 83.7% of the total variance with factor 1 accounting for 37.2%, factor 2- 24.5%, factor 3 -12.9% and factor 4- 9.1%. Examination of the rotated loadings in Table 3 indicates that silt, clay, organic carbon/nitrogen, standard deviation (sorting), and sand (negative) are all high (>0.500) on factor 1. Likewise, gravel (-), inorganic carbon (-), standard deviation (-), and mean grain size have high loadings on factor 2. Skewness (-), and kurtosis (-) have high loadings on factor 3 and only phosphate is high on factor 4.

Figures 9-12 show the spatial distribution of the factor scores that are < -1, and > +1 for each of the factors. These scores are standard deviations from the theoretical factor means, consequently only those scores greater than 1 are significantly different than the mean for that factor. The process modeled by factor 1 is enhanced at areas with positive factor scores and decreased in areas with negative scores. When the variables have significant negative loadings, the factor is strongest in areas with large negative factor scores and vice versa.

The distribution of high and low factor 1 scores is presented in Figure 9. This factor is enhanced in the upper Harbor at the confluence of the Peace and Myakka Rivers and in San Carlos Bay with large negative values in the lower Harbor. The distribution of factor 2 scores is very similar to those of factor 1 with large negative deviations in the lower Harbor and San Carlos Pass/lower Pine Island Sound, and large positive values in the upper Harbor and San Carlos Bay (Figure 10). While the distributions look similar, the effect of the processses are reversed because factor 2 loadings are negative on most of the variables (Table

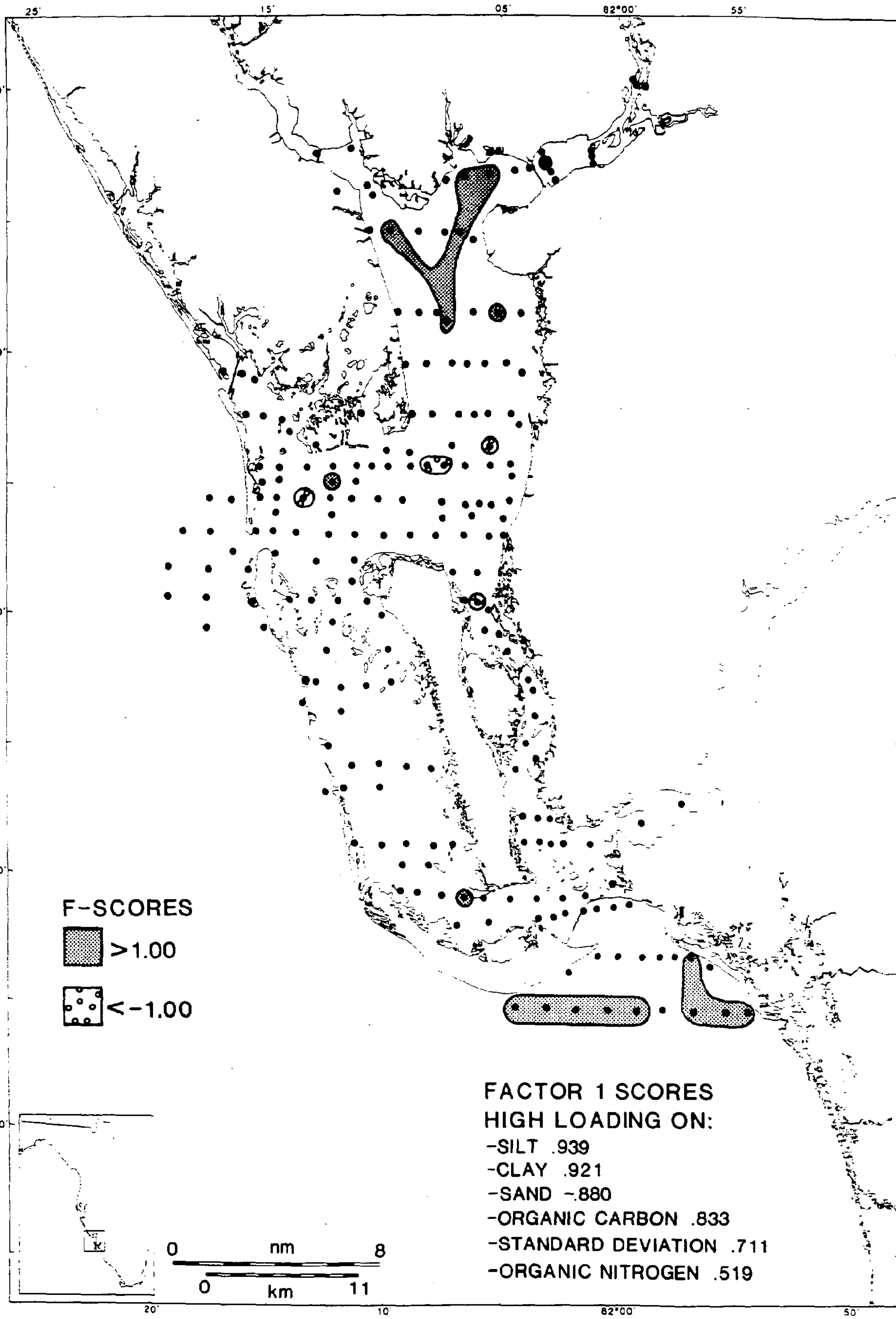


Figure 9. Distribution of factor 1 scores greater than 1 standard deviation from factor means derived from R mode factor analysis.

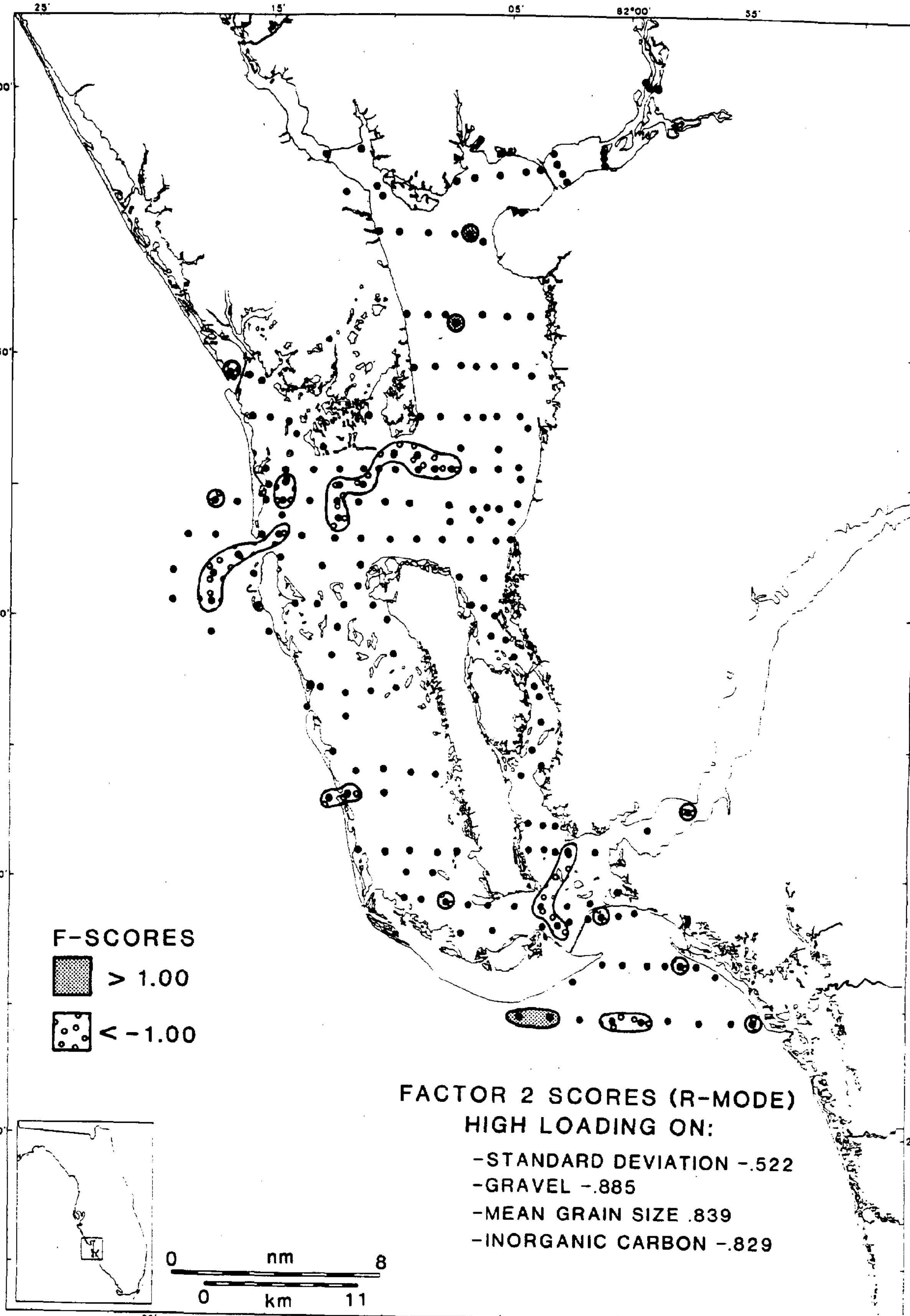


Figure 10. Distribution of factor 2 scores greater than 1 standard deviation from factor mean derived from R mode factor analysis.

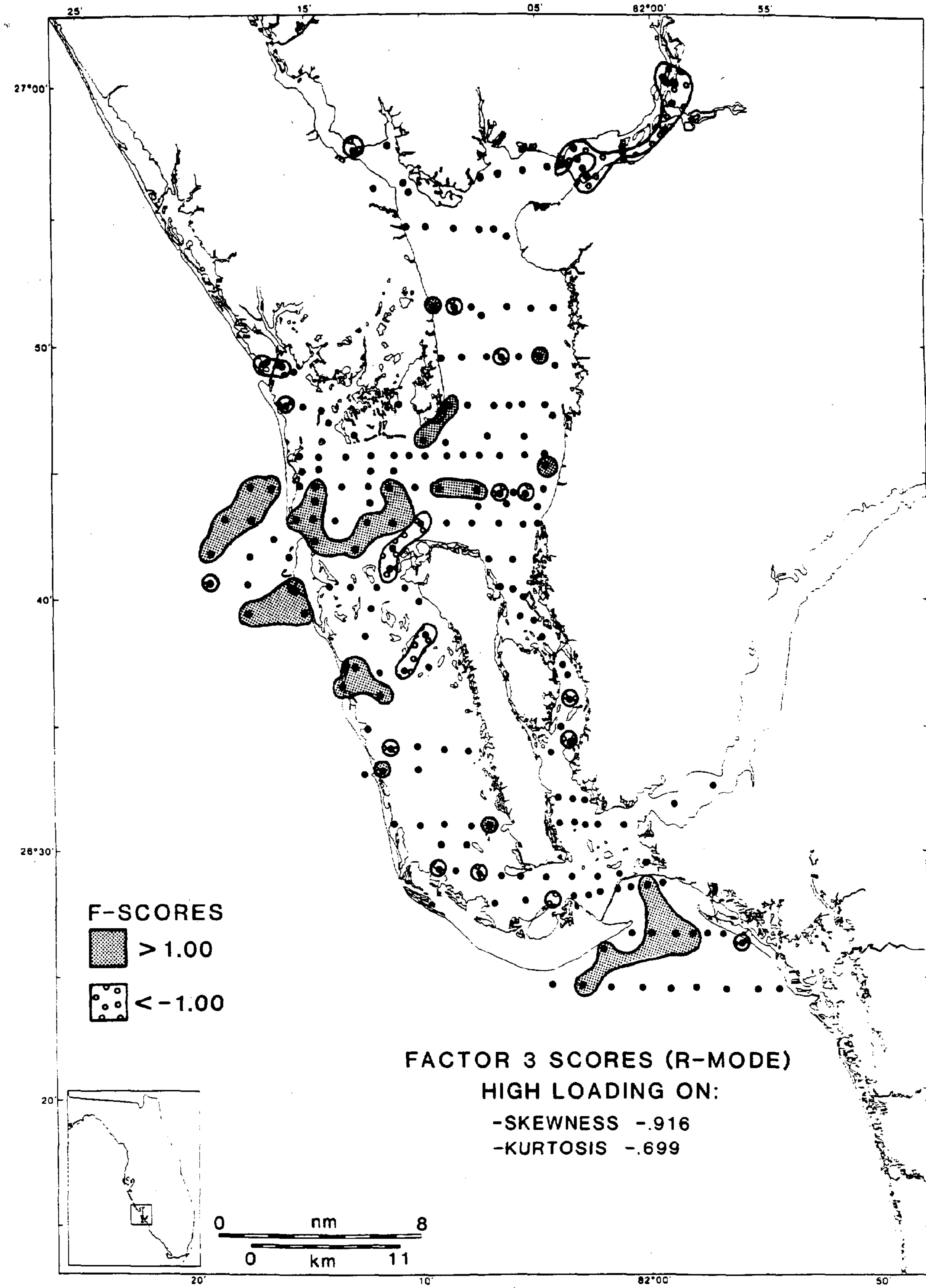


Figure 11. Distribution of factor 3 scores greater than 1 standard deviation from factor mean derived from R mode factor analysis.

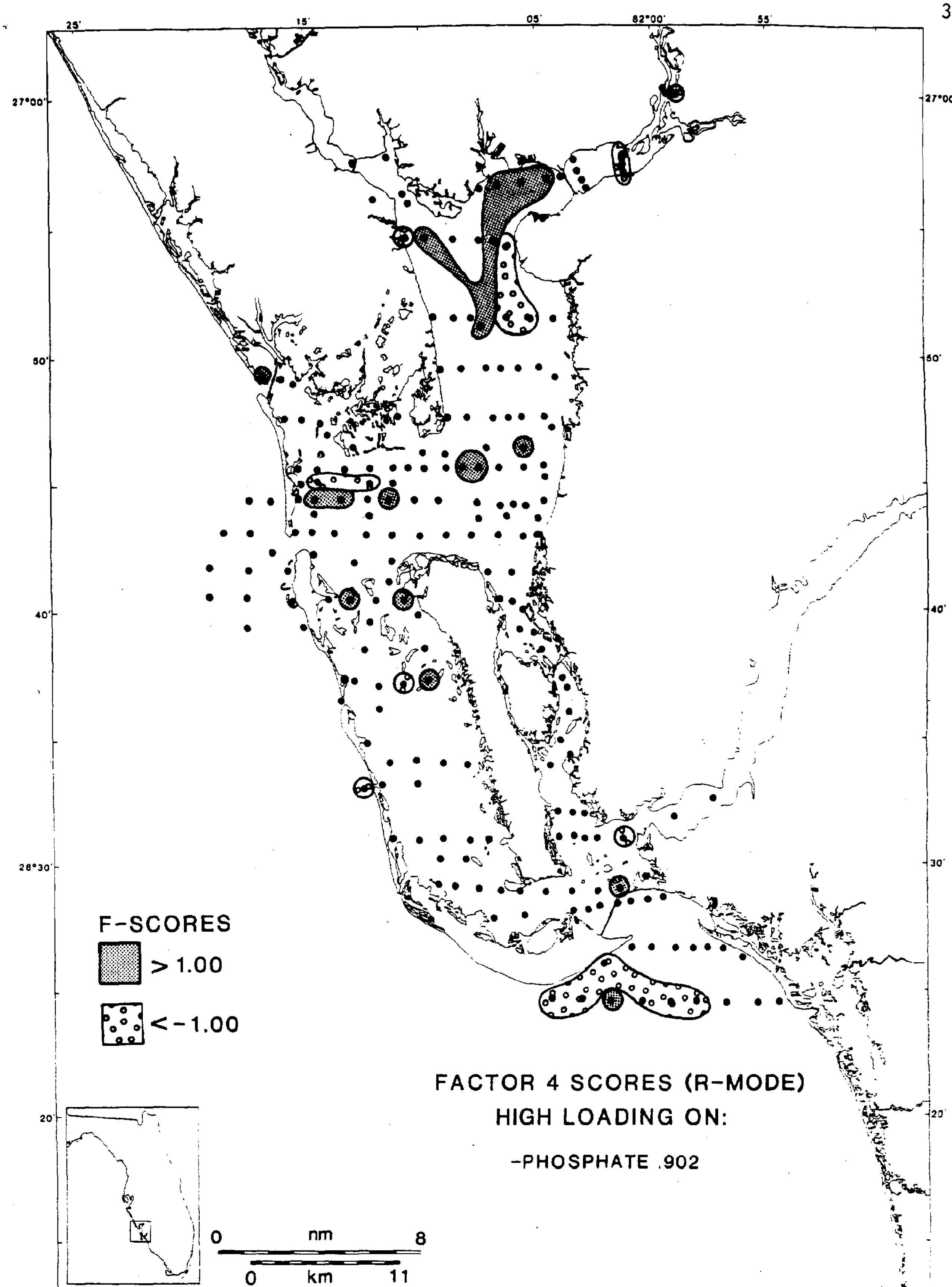


Figure 12. Distribution of factor 4 scores greater than 1 standard deviation from factor mean derived from R mode factor analysis.

3). Therefore, areas of high negative factor 2 scores are dominated by process 2 with respect to processes 1, 3 and 4.

Factor 3 scores show large positive values in the lower Harbor, San Carlos Pass and areas adjacent to the tidal inlets. Large negative values are distributed throughout the lagoons and the estuarine portions of the Peace and Myakka Rivers. Factor 3 loadings have large negative values on the skewness and kurtosis variables so that positive factor scores indicate sediments that are coarsely skewed and platykurtic. Negative factor scores at the river mouths and lagoons reflect finely skewed leptokurtic sediments, and consequently, some process that selectively deposits fine grained, strongly unimodal sediments. The factor 4 scores show large positive values in the upper and lower Harbor and large negative values adjacent to the high values and intermittently throughout the system. Factor 4 loadings are high (.902) only on the % phosphate. Factors with high loadings on only one variable cannot be used to infer process, but simply indicate the distribution of that variable (Klovan, 1975).

The recent sedimentological data of Pierce et al (1982) and Estevez (1986) was analyzed with a Q mode factor analysis using the following variables: median grain size, mean grain size, standard deviation, skewness, kurtosis and % silt/clay. Three factors or sedimentologic end members accounted for 98.4% of the total variance. The rotated loadings are included in the Appendix, the end member distributions in Figure 13 and the summary statistics in Table 4. The sedimentologic units defined from the loadings have different cutpoints than those of the Huang analysis, although the composition of the end members is the same.

Table 3. Rotated R mode factor loadings and communality (h^2) for data of Huang (1966). Factor loadings indicate proportion of variance of each factor accounted for by each variable. Communality indicates proportion of variance of each variable accounted for by factors.

	FACTOR NUMBER				
	1	2	3	4	h^2
silt	0.939	0.112	0.049	0.123	0.91
clay	0.921	0.115	0.045	0.116	0.88
sand	-0.880	0.367	-0.132	-0.082	0.93
org C	0.833	-0.101	0.058	0.215	0.75
sorting	0.711	-0.522	0.227	0.140	0.85
org N	0.519	-0.377	-0.219	0.375	0.60
gravel	0.179	-0.885	0.174	-0.037	0.85
mean grn sz	0.472	0.839	-0.118	0.022	0.94
$CaCO_3$	0.207	-0.829	0.184	-0.083	0.77
skewness	0.045	0.140	0.184	-0.083	0.77
kurtosis	-0.348	0.369	-0.699	-0.180	0.78
phosphate	0.265	-0.139	0.132	0.902	0.92

Table 4. Summary statistics for data from Pierce et al., 1982; and Estevez,

		Fluvial/Upper Est.	Estuarine/Lag.	Inlet/Chan.
MEDIAN (phi)	mean	2.75	2.44	1.13
	min	1.78	1.47	0.10
	max	3.97	3.16	2.32
	std-dev	0.40	0.40	0.86
MEAN GRAIN SIZE (phi)	mean	2.68	2.45	0.96
	min	1.90	1.48	0.45
	max	3.17	3.09	1.80
	std-dev	0.32	0.41	0.59
SORTING (phi)	mean	1.02	0.71	1.65
	min	0.61	0.53	1.32
	max	2.38	1.03	1.92
	std-dev	0.41	0.13	0.19
SKEWNESS	mean	-0.06	0.01	-0.11
	min	-0.73	-0.28	-0.40
	max	0.24	0.27	0.34
	std-dev	0.20	0.13	0.25
KURTOSIS	mean	1.10	1.11	0.79
	min	0.59	0.74	0.64
	max	1.98	1.85	1.28
	std-dev	0.27	0.29	0.20
SILT/CLAY (percent)	mean	9.02	1.06	1.56
	min	2.55	0.29	0.23
	max	49.85	2.20	3.68
	std-dev	11.12	0.59	1.21

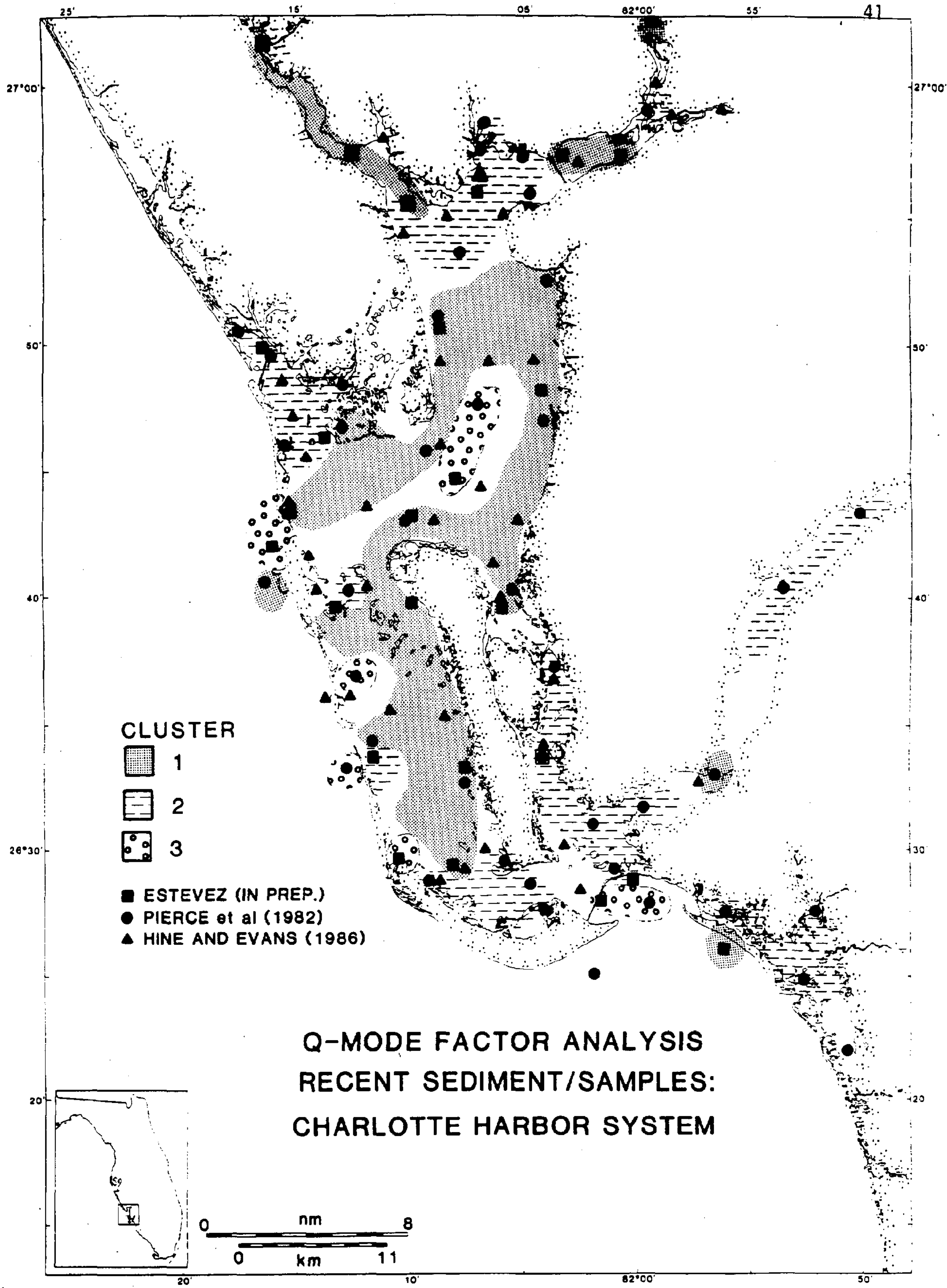


Figure 13. Distribution of sedimentologic units derived from Q mode factor analysis using the data from Pierce et al (1982) and Estevez (1986).

Unit 1 (estuarine/lagoon) has factor 1 loadings 0.800. Unit 2 (fluvial/upper estuarine) has factor 2 values 0.700 and unit 3 (inlet/channel) has factor 3 values 0.400. Compositionally, the units reflect the same end members as the Huang data such that the estuarine/lagoon unit is a moderately sorted fine sand with 1.06% silt/clay. The fluvial/upper estuarine unit is a poorly sorted slightly finer sand with 9.02% silt/clay. The inlet/channel unit is a poorly sorted coarse sand with 1.56% silt/clay (Table 4).

The pattern of distribution of the sedimentologic units is also similar to that produced from the Huang data. However comparison of Figures 7 and 13 shows significant differences. The inlet/channel unit of the recent data is reduced to 8 stations with most of those directly in or adjacent to the inlets. In Figure 7, this unit covers most of the lower Harbor, San Carlos Pass and southern Pine Island Sound. This difference in coverage is probably due to differences in the variables of each data set which are the basis for determining the makeup of the units. Percent gravel and inorganic carbon are the primary diagnostic variables of the inlet/channel unit (Table 2) and are not analyzed in the recent data set.

The fluvial/upper estuarine unit of Figure 13 is more widespread than that of Figure 7. This is due in part to more samples in the upstream areas, but may also reflect increased fine grained deposition and changes in variables measured (organic carbon/nitrogen). Changes in the distribution of the estuarine/lagoon unit are related to the above changes i.e., an increase in the lower Harbor, and a decrease in the upper Harbor and lagoons. The boundaries between these sedimentologic end members are arbitrary as are those of Figure 7. Most of the differences between the 1960's distribution in Figure 7 and 1980's distribution in Figure 13 may be attributed to the use of different variables. However the problem of increased deposition of fine grained sediments needs further analysis.

The results of both of the Q mode factor analyses indicates that 3 distinct sedimentologic end members and the resulting gradations constitute the depositional environments of the Charlotte Harbor system. These members are: a sandy muddy "fluvial/upper estuarine" unit located in the upper Harbor and San Carlos Bay; a shelley sand "inlet/channel" unit adjacent to the tidal inlets in the lower Harbor and San Carlos Pass/lower Pine Island Sound; and a slightly shelley, muddy sand "estuarine/lagoon" unit comprising the lagoons and upper Harbor areas.

The results of the R mode analysis indicates that 83.2% of the variance of 12 sedimentologic variables (% gravel, % sand, % silt, % clay, mean grain size, standard deviation, skewness, kurtosis, % organic carbon, % organic nitrogen, % inorganic carbon and % phosphate) is accounted for by 4 factors. Silt, clay, organic carbon/nitrogen, standard deviation and sand (-)are the variables dominating the variance of factor 1. Factor 2 is a composite of standard deviation (-), gravel (-), inorganic carbon (-) and mean grain size. Skewness (-) and kurtosis (-) dominate the variance of factor 3 and phosphate is the only variable with a high loading on factor 4.

DISCUSSION

The processes controlling sediment deposition in estuarine systems are: waves, tidal currents, freshwater discharge and mixing, sediment supply (including composition and availability), and biologic productivity and sediment reworking (Guilcher, 1967; Postma, 1967). It is the interaction of those processes which produces the sedimentologic environments and controls their distribution in Charlotte Harbor. The R mode factor analysis indicates that 4 factors produce 83% of sedimentologic variation. Three processes may be inferred from those factors by synthesizing the measured variables that comprise each of those factors and the areas where each of those factors is strongest and weakest (Figures 9-12).

Factor 1 which has high loadings on the parameters of fine grained deposition (silt, clay, organic C/N and sorting) models a process that is most active in the upper estuarine areas where the Peace/Myakka Rivers discharge into Charlotte Harbor and the Caloosahatchee into San Carlos Bay. These areas do not represent the estuarine turbidity maxima which occur at the initial saltwater-freshwater mixing zone (Postma, 1967; Meade, 1972). This mixing zone which is the area of maximum fine grained deposition normally occurs well upstream of the upper Harbor (Stoker, 1985).

The fine grained sediments of Charlotte Harbor are composed of inorganic clay minerals and organically produced detritus. Fine grained organics will accumulate in any biologically productive, quiescent area (i.e., sheltered areas of Pine Island or Gasparilla Sounds) which all possess moderate or average factor 1 scores. It should also be noted that factor 1 accounts for 37% of the total variance (R mode; see Appendix). Thus the process modeled by factor 1 is the single largest control of sediments in the system, it acts primarily on mud sized particles (0.0625 mm) and it is enhanced where the rivers discharge into their respective embayments. Using these criteria, factor 1 apparently models the pattern of residual, low velocity currents established throughout the estuarine system.

These currents which are under investigation by the U.S. Geological Survey, Tampa Sub-district (Goodwin, pers. comm.) act to homogenize the distribution of mud sized particles throughout the system and are not competent to transport sand sized particles. Increased amounts of mud in the upper estuarine areas is due to the interaction of the currents with increased sediment supply from the rivers. It is significant to note that there are very few areas of decreased factor 1 scores (Figure 9) relative to the area of inlet/channel deposition (Figure 7). The combined silt/clay % from the inlet/channel units and sub-units (Table 2) show mean mud concentrations from 5-8%. These areas which are dominated by strong tidal currents apparently accumulate some fine grained sediments during slack tides that are not removed during the subsequent period of high velocity currents.

Factor 2 (Figure 10) accounts for 24.5% of the total variance with high loadings on standard deviation (-), gravel (-), inorganic carbon (-), and mean grain size. These variables are all related to the distribution of coarse particles, primarily as shell-gravel. Standard deviation or sorting is significant on both factor 1 and 2 which illustrates that sorting anomolies can occur from high proportions of either fine or coarse particles.

The distribution of high negative factor 2 scores occurs in the tidal inlets and channelized portions of the lower Harbor, southern Pine Island Sound and San Carlos Bay. The co-occurrence of the predominantly negative loadings and negative factor scores indicate that factor 2 models deposition controlled by accelerated tidal currents. Comparison of the distribution of the factor 2 scores (Figure 10) and the inlet/channel unit of Figure 7 shows very good correlation. Comparison of those distributions with the bathymetric map (Figure 2) shows that the process and depositional environment correspond to the deep channels.

The residual currents identified as factor 1 and the channelized, accelerated tidal currents identified as factor 2 are end members of the continuum of hydraulic processes in the estuarine system. They cannot be isolated from the overall pattern of hydraulic transport in the Harbor. Sedimentologically however, they control different ranges of the particle size distributions and operate most effectively in different parts of the estuarine system.

Factor 3 has high negative loadings on skewness and kurtosis. Both variables are related to the size frequency distribution of the sediment samples. Skewness is a measure of the asymmetry of the distribution and kurtosis is the ratio of sorting in tails (fine and coarse end members) to the sorting in the central portion of the distribution. The spatial plots of the factor 3 scores (Figure 11) shows that sediments adjacent to the inlets are coarsely skewed and platykurtic. The platykurtic nature of these sediments indicates good sorting in the tails and/or a bi-model sediment distribution (Folk, 1980). The combination of high concentrations of shell gravel and relatively high silt/clay (table 2) suggests that a bi-model distribution is prevalent.

The high negative factor 3 scores (Figure 11) indicate finely skewed, leptokurtic sediments throughout Pine Island/Gasparilla Sounds, the upper harbor, amd lowermost Peace River. These values indicate the sediments are skewed to the fine grain sizes and that the tails are poorly sorted relative to the central portion of the samples. The above parameters do not allow any specific process to be assigned to factor 3 although possibilities are the effects of waves along shoals and shorelines, the proportion of hydraulically transported vs. in situ growth of mollusc shells or intermittant high energy events (e.g. floods, storms, etc.).

Factor 4 which has high loadings only on the % phosphate cannot be used to infer process and illustrates only the distribution and importance of the phosphate variable (9.10% of the total variance). Additionally, because Huang (1966) used the 2 micron size range in the XRD phosphate analysis, this variable ignores the silt to sand sized phosphate which constitutes a major portion of the sedimentary phosphorus (Grace, 1977).

Grace (1977) showed that most of the fine, mud sized phosphorus was located in the estuarine portion of the Peace River and probably associated with aperiodic clay slime spills from upstream phosphate processing plants. The distribution of high factor 4 scores (Figure 12) indicates concentrations of high phosphate in the lower Peace River, upper Harbor and within the deep tidal channels of the lower Harbor. If the Peace River is the source of the phosphate, as opposed to exposure of underlying phosphate-rich deposits, this indicates that the deep tidal channels are an area of accumulation for these clay sized sediments.

Two stratigraphic cross sections (Figures 14 and 15) created from the vibracore data of Hine and Evans (1986) illustrate the 3-dimensional distribution of sedimentologic units (table 2). Four stratigraphic units are recognized (relative to 3 sedimentologic units) in the series of cores extending from the Peace River to Pine Island Sound (Figure 14). These units are: 1) fluvial/upper estuarine unit of sand-mud interbeds, 2) a lower estuarine bioturbated muddy sand, 3) an esuarine channel unit of shelley sand, and 4) a lagoon-flood tidal delta unit of fining upwards, shelley to muddy sands.

The estuarine/lagoon sedimentologic unit (Figure 7; Table 2) is subdivided into lagoon and estuarine members that are sedimentologically similar but stratigraphically distinct. Figure 15 is an E-W cross section across Pine Island Sound. The lagoon-FTD unit consists of repetitive fining upwards sequences that culminate in slightly shelley, muddy sands which are essentially analagous to the lower estuarine muddy sands. The variable repetitive deposition in the lagoons is due to the development and migration of flood tidal deltas. The lateral distribution of these sedimentologically variable, fining upwards sequences throughout the lagoons precludes deposition of some single sediment type specific to the lagoon environment.

Using similar reasoning, the fluvial/upper estuarine sediment unit which is restricted to 4 samples in the upper Harbor (and 5 samples in San Carlos Bay) is composed of the mud end member of the sand-mud interbeds of the fluvial/upper estuarine stratigraphic unit. Consequently, the lateral distribution of fluvially derived or controlled

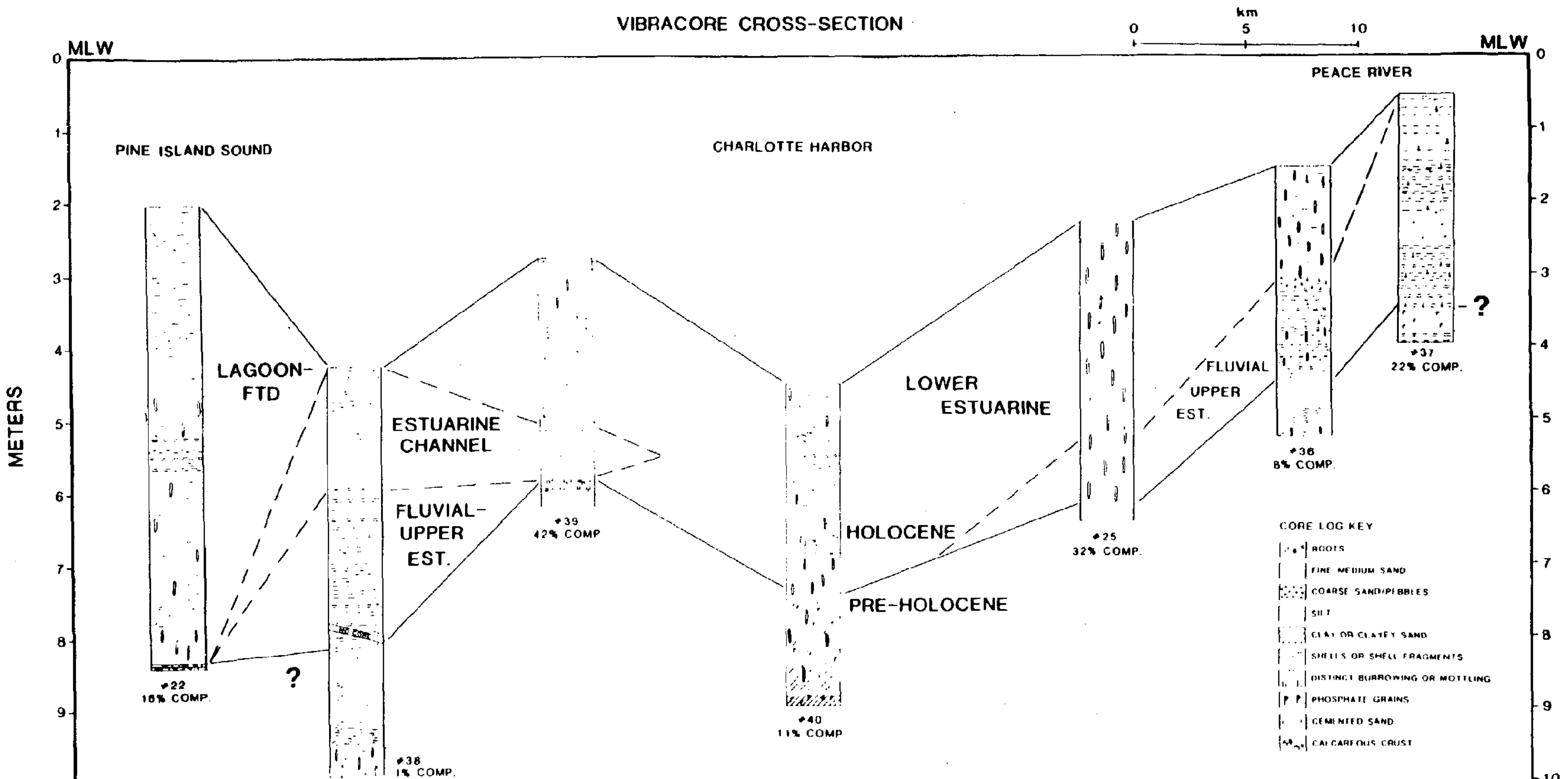


Figure 14. Stratigraphic cross section from the Peace River to Pine Island Sound based on data from Hine and Evans (1986).

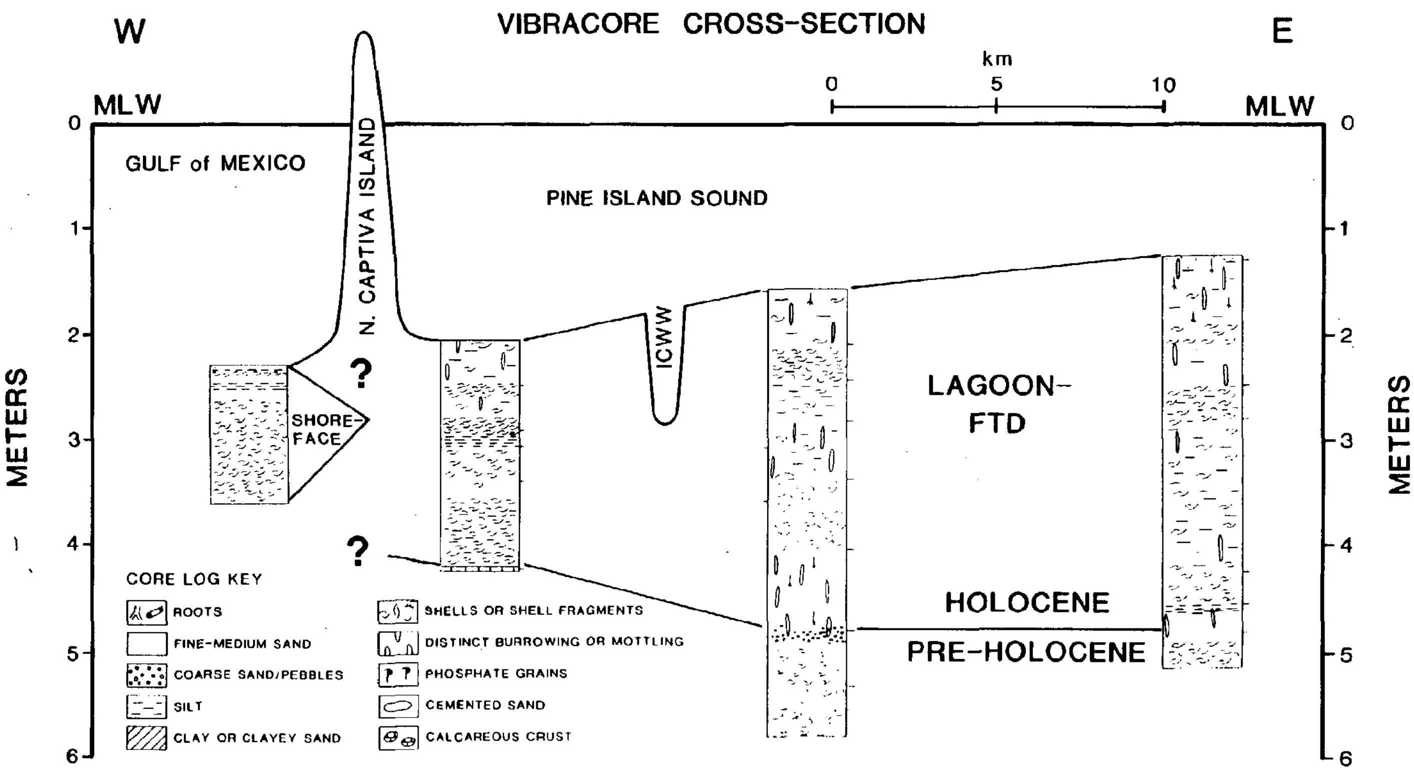


Figure 15. Stratigraphic cross section across Pine Island Sound showing distribution of lagoonal facies.

deposits is probably much more widespread than what is indicated by the mud end member alone.

Estevez (1986) concluded that the distribution of benthic infauna followed hydrographic trends and sediment type was relatively unimportant. However, he also concluded that the polychaete and crustacean assemblages were widely dispersed throughout the estuary and that "Overall, communities of the system are combinations of a broadly dispersed fauna rather than separate or coherent groups." These conclusions are the same as those of this study which show that sedimentologic variables and hydraulic processes inferred from them are present as a gradual continuum throughout the estuarine system.

The hydrographic variables measured by Estevez (e.g. temperature, salinity and dissolved oxygen) are directly controlled by hydraulic processes as are the sedimentologic variables. Direct correlations between benthic populations and sedimentologic variables should be difficult to detect because benthic fauna respond to short term hydrographic variations while sediments accumulate over a period of years and/or are homogenized by the burrowing and feeding of benthic fauna.

Radiocarbon dates on 5 vibracores have been obtained by Pierce et al (1982). Sedimentation rates calculated from those dated samples range from 1.43 to 11.76 cm/100 years and average 5.95 cm/100 years. Historic alterations in the depositional regime between the sampling period of Huang (1966) and Pierce et al (1982) and Estevez (1986) are difficult to quantify because of the overall slow sedimentation rate and homogenization by benthos.

Most of the differences in the distribution patterns between Figures 7 and 13 are attributed to problems of facies quantification and the lack of consistency between the old and new data sets. This could be partially rectified by re-analyzing the Huang (1966) data using only those variables available in the later data sets. However the uniform distribution of Huang's sample stations is not duplicated by the later studies which are based upon a fewer number of samples and selective sampling of the range of estuarine environments.

The net result of the slow deposition rates and faunal reworking is that sedimentary environments will change slowly. For example, if the sediment particles accumulating in an area change from sand sized to mud sized, reworking will homogenzie the mud particles into the upper 10-20 cm of the sediment column so that there is little net change in the unit. The converse side of this problem is that old data such as that of Huang (1966) may still be considered a reliable indicator of sedimentologic environments.

This study has defined 3 sedimentologic units and 4 sub-units that are apparently controlled by the interaction of two primary hydraulic processes; residual currents which operate throughout the estuarine system and dominate fine grained deposition, and accelerated tidal currents which are localized near the inlets and control coarse shell-gravel deposition. These interpretations are based upon R and Q mode factor analyses which quantitatively describe the relationships between sedimentologic variables and sample stations. Predictive quantification of those relationships requires a multi-variate regression between the dependent sedimentologic variables and the independent hydraulic processes. Ongoing work by the Geological Survey may provide the quantitative hydraulic data necessary to validate the interpretations of this study.

the quantitative hydraulic data necessary to validate the interpretations of this study.

CONCLUSIONS

This study defines and delineates the sedimentary environments of the Charlotte Harbor estuarine system by meeting the following objectives:

1) to assemble and summarize previous studies containing sedimentologic data,
2) to re-analyze that data in order to delineate sedimentary environments and define the controlling depositional processes,
3) to integrate newer, more limited data sets with the older, comprehensive data of Huang (1966),
4) present the sedimentologic data in an understandable format for resource planners and managers with non-geologic backgrounds.

With respect to objective 1, there are relatively few studies dealing with the sedimentology of Charlotte Harbor (Huang, 1966; Grace, 1977; Pierce et al, 1982; Hine and Evans, 1986; and Estevez, 1986). Of these, only Huang (1966; published as Huang and Goodell, 1967) deals with surface sedimentology of the entire estuarine system

Q mode factor analysis and k-means cluster analyses defined 3 sedimentologic units and 4 sub-units from the Huang data set. A <u>fluvial/upper estuarine unit</u> (4% of all samples) is a very poorly sorted coarse silt with high concentrations of organic C/N and phosphorus (1.91, 0.13 and 4.15 %, resp.). This unit occurs only at the confluence of the Myakka and Peace Rivers and in San Carlos Bay. The estuarine/lagoon unit which is found predominantly throughout the upper Harbor and lagoons (47% of all samples) is a poorly sorted fine sand with moderately low values of organic C/N and phosphorus (0.46, 0.04 and 1.50%, resp.).

The inlet/channel unit which occurs at 49% of all stations is located adjacent to the tidal passes with most of the samples in the lower Harbor near Boca Grande Pass and in San Carlos Pass/southern Pine Island Sound. The sediments in this unit are poorly sorted fine sand with 7.73% shell-gravel and 43.54% carbonate. Organic C/N and phosphorus are all low with values of 0.79, 0.07 and 1.76 %, resp. Sub-units within the inlet/channel unit are composed of predominantly sandy, shelley and muddy members. Sub-units within the estuarine/lagoon are composed of sandy and muddy members with consistently low proportions of shell-gravel.

The R mode factor analysis indicated that 4 factors account for 83.7% of the variance between the 12 measured variables. Factor 1 accounts for 37.2% of the variance and has high loadings on silt, clay, organic C and N, standard deviation and sand (-). This factor is interpreted as modeling the residual currents that homogenize fine grained deposition in that area due to increased suspended load concentrations in the Rivers.

Factor 2 loadings are high on gravel (-), inorganic carbon (-), standard deviation (-), and mean grain size. These variables reflect control of coarse grained sediments and scores are highest adjacent to the inlets. This factor models depositional control by accelerated tidal currents. Factor 3 is dominated by the skewness and kurtosis variables, but there is insufficient data for interpretation of a depositional process. Factor 4 has a high loading only on the % phosphate and reflects the distribution of that variable. The phosphate concentrations are highest in the upper estuary in the fluvial/upper estuarine unit and in the lower Harbor associated with inlet/channel deposits.

Comparison of old (mid-1960's) data with recent sedimentological data (1980's) has not shown any quantifiable differences in sedimentologic environments, although areal expansion of fine grained fluvial/upper estuarine deposition needs further analysis. The most important aspect of that comparison is that the mid-1960's data of Huang (1966) may be applicable to the existing surficial deposits due to slow deposition rates (5.95 cm/100 years).

The generally homogeneous deposits of the Charlotte Harbor system exist as a continuum between the 3 depositional components; shell-gravel, quartz sand, and inorganic clay/organic detritus mud. Distribution of the sedimentologic end members is controlled by a continuum of process. The two identified end member processes are residual circulation and accelerated tidal currents. Additional processes inherent to estuaries such as waves and estuarine mixing are either contained within the effects of residual currents or act as random variation in the control of depositional properties.

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Appendices

. LATENT ROOTS (EIGENVALUES

Q Mode Factor Analysis Part 1

(samples 1-150: Huang data)

1	2	3	4	5
140.857	7.420	1.066	0.435	0.174
6	7	8	9	10
0.027	0.015	0.004	0.001	0.001
11	12	13	14	15
0.000	0.000	0.000	0.000	0.000
16	17	18	19	20
0.000	0.000	0.000	0.000	0.000
21	22	23	24	25
0.000	0.000	0.000	0.000	0.000
26	27	28	29	30
0.000	0.000	0.000	0.000	0.000
31	32	33	34	35
0.000	0.000	0.000	0.000	0.000
36	37	38	39	40
0.000	0.000	0.000	0.000	0.000
41	42	43	44	45
0.000	0.000	0.000	0.000	0.000
46	47	48	49	50
0.000	0.000	0.000	0.000	0.000
51	52	53	54	55
0.000	0.000	0.000	0.000	0.000
56	57	58	59	60
0.000	0.000	0.000	0.000	0.000
61	62	63	64	65

0.000	0.000	0.000	0.000	0.000
66	67	68	69	70
0.000	0.000	0.000	0.000	0.000
71	72	73	74	75
0.000	0.000	0.000	0.000	0.000
76	77	78	79	80
0.000	0.000	0.000	0.000	0.000
81	82	83	84	85
0.000	0.000	-0.000	-0.000	-0.000
86	87	88	89	90
-0.000	-0.000	-0.000	-0.000	-0.000
91	92	93	94	95
-0.000	-0.000	-0.000	-0.000	-0.000
96	97	98	99	100
-0.000	-0.000	-0.000	-0.000	-0.000
101	102	103	104	105
-0.000	-0.000	-0.000	-0.000	-0.000
106	107	108	109	110
-0.000	-0.000	-0.000	-0.000	-0.000
111	112	113	114	115
-0.000	-0.000	-0.000	-0.000	-0.000
116	117	118	119	120
-0.000	-0.000	-0.000	-0.000	-0.000
121	122	123	124	125
-0.000	-0.000	-0.000	-0.000	-0.000
126	127	128	129	130

131	132	133	134	135
-0.000	-0.000	-0.000	-0.000	-0.000
136	137	138	139	140
-0.000	-0.000	-0.000	-0.000	-0.000
141	142	143	144	145
-0.000	-0.000	-0.000	-0.000	-0.000
146	147	148	149	150
-0.000	-0.000	-0.000	-0.000	-0.000

COMPONENT LOADINGS

	1	2	3
COL(1)	0.986	0.142	0.051
COL(2)	0.992	0.114	-0.022
COL(3)	0.993	0.113	-0.002
COL(4)	0.993	0.111	-0.014
COL(5)	0.985	0.129	0.073
COL(6)	0.993	0.118	0.022
COL(7)	0.979	0.146	0.097
COL(8)	0.978	0.128	-0.141
COL(9)	0.995	0.102	0.016
COL(10)	0.986	0.113	0.065
COL(11)	0.985	-0.152	-0.015
COL(12)	0.994	0.107	0.019
COL(13)	0.997	-0.056	0.039
COL(14)	0.996	0.089	-0.014
COL(15)	0.994	0.104	-0.005
COL(16)	0.985	0.097	0.134
COL(17)	0.846	0.034	-0.519
COL(18)	0.982	0.095	-0.164
COL(19)	0.993	0.068	-0.056
COL(20)	0.968	0.158	0.123
COL(21)	0.994	0.106	0.032
COL(22)	0.943	0.125	-0.304
COL(23)	0.996	0.086	0.009
COL(24)	0.995	0.096	-0.017
COL(25)	0.874	0.083	-0.468
COL(26)	0.990	0.113	0.056
COL(27)	0.991	0.097	-0.010
COL(28)	0.991	0.103	0.057
COL(29)	0.993	0.113	0.038
COL(30)	0.917	0.062	-0.390
COL(31)	0.995	0.100	0.005
COL(32)	0.981	0.109	-0.154
COL(33)	0.997	0.069	0.023
COL(34)	0.646	-0.753	0.052
COL(35)	0.981	0.117	0.088
COL(36)	0.994	0.107	0.016
COL(37)	0.988	0.129	0.070
COL(38)	0.996	0.091	0.013

COL(40)	0.994	0.104	0.033
COL(41)	0.994	0.109	0.028
COL(42)	0.993	0.108	0.033
COL(43)	0.993	0.107	0.014
COL(44)	0.991	0.126	0.031
COL(45)	0.996	0.089	-0.019
COL(46)	0.993	0.112	0.008
COL(47)	0.993	0.109	-0.037
COL(48)	0.993	0.109	-0.035
COL(49)	0.993	0.095	0.001
COL(50)	0.995	0.104	-0.001
COL(51)	0.996	0.029	-0.078
COL(52)	0.988	-0.028	-0.148
COL(53)	0.999	-0.012	-0.039
COL(54)	0.994	0.105	0.030
COL(55)	0.994	0.094	0.009
COL(56)	0.994	0.108	0.011
COL(57)	0.968	-0.164	-0.010
COL(58)	0.773	-0.634	-0.027
COL(59)	0.990	0.110	-0.064
COL(60)	0.993	0.089	-0.008
COL(61)	0.995	0.098	0.020
COL(62)	0.993	0.101	0.032
COL(63)	0.994	0.101	0.031
COL(64)	0.998	0.026	-0.050
COL(65)	0.997	-0.067	0.002
COL(66)	0.794	-0.601	0.009
COL(67)	0.938	-0.336	-0.061
COL(68)	0.835	-0.543	-0.083
COL(69)	0.911	-0.409	0.014
COL(70)	0.954	-0.293	0.017
COL(71)	0.991	-0.129	0.004
COL(72)	0.998	0.056	-0.034
COL(73)	0.992	0.118	0.045
COL(74)	0.992	0.097	-0.005
COL(75)	0.998	0.059	0.024
COL(76)	0.771	-0.632	0.015
COL(77)	0.646	-0.752	-0.079
COL(78)	0.773	-0.621	-0.002
COL(79)	0.956	-0.193	0.029
COL(80)	0.998	0.046	0.024
COL(81)	0.994	0.096	0.018
COL(82)	0.975	-0.020	0.017
COL(83)	0.987	-0.124	0.005
COL(84)	0.985	-0.055	0.001
COL(85)	0.995	-0.027	-0.004
COL(86)	0.924	-0.380	0.010
COL(87)	0.860	-0.505	0.012
COL(88)	0.998	0.051	0.020
COL(89)	0.993	0.074	0.058
COL(90)	0.994	0.106	0.018
COL(91)	0.991	0.117	0.047
COL(92)	0.992	0.120	-0.022
COL(93)	0.993	-0.095	0.022
COL(94)	0.777	-0.627	0.019
COL(95)	0.999	0.035	0.020
COL(96)	0.999	0.026	0.037
COL(97)	0.994	0.093	0.003
COL(98)	0.999	0.017	0.024
COL(99)	0.998	0.047	0.029
COL(100	0.991	0.090	0.017
COL(101	0.779	-0.622	0.019
COL(102	0.892	-0.445	0.009
COL(103	0.999	0.008	0.016
COL(104	0.994	0.083	0.022

COL(105			
COL(106	0.990	0.116	0.067
COL(107	0.975	0.048	0.072
COL(108	0.992	0.118	0.047
COL(109	0.990	0.126	0.052
COL(110	0.993	0.109	0.023
COL(111	0.511	-0.828	0.076
COL(112	0.998	0.009	0.001
COL(113	0.845	-0.533	0.022
COL(114	0.942	-0.329	0.019
COL(115	0.993	-0.103	0.002
COL(116	1.000	-0.009	0.026
COL(117	0.991	-0.100	0.032
COL(118	0.994	0.104	0.041
COL(119	0.994	0.107	0.037
COL(120	0.987	0.133	0.057
COL(121	0.974	0.118	0.111
COL(122	0.903	-0.426	0.031
COL(123	0.989	-0.133	0.010
COL(124	0.995	-0.057	-0.067
COL(125	0.995	0.097	-0.013
COL(126	0.991	0.125	0.032
COL(127	0.997	0.081	0.007
COL(128	0.993	0.104	0.012
COL(129	0.993	0.106	0.017
COL(130	0.994	0.110	0.021
COL(131	0.999	-0.001	0.007
COL(132	0.994	-0.095	0.001
COL(133	0.994	0.101	0.039
COL(134	0.995	0.095	0.041
COL(135	0.992	0.120	0.023
COL(136	0.993	0.106	0.019
COL(137	0.995	0.094	0.023
COL(138	0.979	0.146	0.097
COL(139	0.991	0.089	0.010
COL(140	0.946	-0.323	0.008
COL(141	0.991	-0.128	0.005
COL(142	0.995	0.099	0.001
COL(143	0.983	0.140	0.088
COL(144	0.993	0.102	-0.050
COL(145	0.992	0.126	0.003
COL(146	0.989	0.130	0.061
COL(147	0.993	0.052	0.009
COL(148	0.989	-0.145	0.013
COL(149	0.996	-0.046	0.046
COL(150	0.994	0.112	0.012

VARIANCE EXPLAINED BY COMPONENTS

1	2	3
140.857	7.420	1.066

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3
93.905	4.947	0.710

ROTATED LOADINGS

	1	2	3
COL(1)	0.927	0.360	0.082
COL(2)	0.909	0.384	0.154
COL(3)	0.913	0.384	0.135
COL(4)	0.910	0.388	0.146
COL(5)	0.927	0.363	0.060
COL(6)	0.917	0.382	0.111
COL(7)	0.928	0.355	0.036
COL(8)	0.889	0.360	0.271
COL(9)	0.910	0.397	0.116
COL(10)	0.925	0.368	0.065
COL(11)	0.774	0.613	0.137
COL(12)	0.912	0.393	0.114
COL(13)	0.838	0.537	0.090
COL(14)	0.901	0.408	0.146
COL(15)	0.908	0.394	0.137
COL(16)	0.880	0.391	0.269
COL(17)	0.680	0.363	0.625
COL(18)	0.873	0.390	0.293
COL(19)	0.879	0.423	0.217
COL(20)	0.929	0.339	0.004
COL(21)	0.914	0.394	0.101
COL(22)	0.836	0.339	0.427
COL(23)	0.903	0.411	0.123
COL(24)	0.903	0.402	0.149
COL(25)	0.735	0.336	0.580
COL(26)	0.922	0.378	0.077
COL(27)	0.901	0.399	0.142
COL(28)	0.913	0.396	0.075
COL(29)	0.917	0.388	0.095
COL(30)	0.771	0.376	0.508
COL(31)	0.908	0.398	0.128
COL(32)	0.860	0.376	0.283
COL(33)	0.897	0.427	0.109
COL(34)	0.195	0.974	0.011
COL(35)	0.915	0.380	0.044
COL(36)	0.912	0.392	0.117
COL(37)	0.925	0.372	0.063
COL(38)	0.905	0.407	0.119
COL(39)	0.899	0.415	0.134
COL(40)	0.913	0.396	0.100
COL(41)	0.914	0.391	0.105
COL(42)	0.914	0.392	0.100
COL(43)	0.911	0.392	0.114
COL(44)	0.921	0.375	0.102
COL(45)	0.900	0.407	0.131
COL(46)	0.913	0.387	0.124
COL(47)	0.906	0.388	0.169
COL(48)	0.906	0.388	0.167
COL(49)	0.904	0.402	0.132
COL(50)	0.909	0.395	0.133
COL(51)	0.864	0.458	0.208
COL(52)	0.820	0.501	0.275
COL(53)	0.851	0.496	0.169
COL(54)	0.913	0.395	0.102
COL(55)	0.905	0.404	0.123
COL(56)	0.912	0.392	0.122
COL(57)	0.754	0.615	0.131
COL(58)	0.354	0.929	0.110
COL(59)	0.901	0.385	0.196
COL(60)	0.899	0.407	0.140
COL(61)	0.909	0.401	0.113
COL(62)	0.911	0.398	0.101
COL(63)	0.911	0.398	0.102

[illegible]	[illegible]	[illegible]	[illegible]
COL(65)	0.828	0.546	0.126
COL(66)	0.392	0.912	0.077
COL(67)	0.638	0.748	0.174
COL(68)	0.445	0.878	0.175
COL(69)	0.588	0.801	0.093
COL(70)	0.682	0.722	0.099
COL(71)	0.793	0.597	0.121
COL(72)	0.884	0.436	0.165
COL(73)	0.919	0.383	0.088
COL(74)	0.903	0.400	0.137
COL(75)	0.893	0.436	0.108
COL(76)	0.359	0.928	0.068
COL(77)	0.180	0.968	0.142
COL(78)	0.364	0.919	0.085
COL(79)	0.735	0.636	0.090
COL(80)	0.887	0.448	0.107
COL(81)	0.907	0.403	0.115
COL(82)	0.834	0.494	0.109
COL(83)	0.792	0.591	0.120
COL(84)	0.823	0.529	0.126
COL(85)	0.845	0.510	0.133
COL(86)	0.613	0.783	0.099
COL(87)	0.496	0.861	0.086
COL(88)	0.889	0.443	0.112
COL(89)	0.901	0.422	0.074
COL(90)	0.912	0.394	0.114
COL(91)	0.919	0.383	0.086
COL(92)	0.912	0.379	0.155
COL(93)	0.813	0.569	0.105
COL(94)	0.366	0.926	0.065
COL(95)	0.882	0.458	0.112
COL(96)	0.880	0.466	0.094
COL(97)	0.904	0.405	0.129
COL(98)	0.873	0.474	0.107
COL(99)	0.888	0.447	0.102
COL(100	0.901	0.406	0.115
COL(101	0.370	0.924	0.065
COL(102	0.553	0.824	0.094
COL(103	0.868	0.481	0.114
COL(104	0.901	0.414	0.110
COL(105	0.907	0.409	0.078
COL(106	0.920	0.385	0.066
COL(107	0.891	0.447	0.069
COL(108	0.920	0.383	0.066
COL(109	0.923	0.376	0.081
COL(110	0.913	0.391	0.110
COL(111	0.046	0.974	-0.033
COL(112	0.866	0.479	0.129
COL(113	0.471	0.878	0.073
COL(114	0.654	0.747	0.094
COL(115	0.807	0.574	0.125
COL(116	0.861	0.497	0.104
COL(117	0.811	0.572	0.093
COL(118	0.914	0.396	0.092
COL(119	0.914	0.393	0.096
COL(120	0.924	0.369	0.076
COL(121	0.912	0.376	0.020
COL(122	0.575	0.814	0.075
COL(123	0.790	0.599	0.115
COL(124	0.822	0.533	0.194
COL(125	0.905	0.401	0.145
COL(126	0.920	0.376	0.101
COL(127	0.901	0.416	0.125
COL(128	0.910	0.394	0.121
COL(129	0.911	0.393	0.116

COL(130	0.714	[illegible]	[illegible]
COL(131	0.862	0.489	0.123
COL(132	0.811	0.568	0.126
COL(133	0.912	0.398	0.093
COL(134	0.910	0.404	0.091
COL(135	0.918	0.380	0.110
COL(136	0.912	0.391	0.113
COL(137	0.908	0.405	0.109
COL(138	0.929	0.354	0.036
COL(139	0.900	0.407	0.122
COL(140	0.659	0.743	0.106
COL(141	0.793	0.596	0.121
COL(142	0.907	0.399	0.131
COL(143	0.927	0.361	0.043
COL(144	0.901	0.394	0.181
COL(145	0.918	0.374	0.130
COL(146	0.926	0.369	0.073
COL(147	0.884	0.440	0.122
COL(148	0.784	0.610	0.112
COL(149	0.842	0.529	0.080
COL(150	0.914	0.388	0.121

VARIANCE EXPLAINED BY ROTATED COMPONENTS

1	2	3
106.693	39.204	3.445

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3
71.129	26.136	2.297

COL(141	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
COL(142	0.682	0.284	0.750	0.840	0.449
COL(143	0.977	0.906	0.503	0.313	0.414
COL(144	0.967	0.748	0.751	0.619	0.587
COL(145	0.861	0.515	0.743	0.767	0.609
COL(146	0.922	0.622	0.654	0.611	0.476

	COL(141	COL(142	COL(143	COL(144	COL(145
COL(141	1.000				
COL(142	0.970	1.000			
COL(143	0.491	0.524	1.000		
COL(144	0.679	0.754	0.935	1.000	
COL(145	0.895	0.926	0.752	0.903	1.000
COL(146	0.876	0.879	0.825	0.916	0.971

	COL(146
COL(146	1.000

LATENT ROOTS (EIGENVALUES)

1	2	3	4	5
130.568	11.850	2.474	0.629	0.325
6	7	8	9	10
0.129	0.013	0.004	0.002	0.001
11	12	13	14	15
0.001	0.000	0.000	0.000	0.000
16	17	18	19	20
0.000	0.000	0.000	0.000	0.000
21	22	23	24	25
0.000	0.000	0.000	0.000	0.000
26	27	28	29	30
0.000	0.000	0.000	0.000	0.000
31	32	33	34	35
0.000	0.000	0.000	0.000	0.000
36	37	38	39	40
0.000	0.000	0.000	0.000	0.000

Q Mode Factor Analysis Part 2

(samples 70-215: Huang data)

41	42	43	44	45
0.000	0.000	0.000	0.000	0.000
46	47	48	49	50
0.000	0.000	0.000	0.000	0.000
51	52	53	54	55
0.000	0.000	0.000	0.000	0.000
56	57	58	59	60
0.000	0.000	0.000	0.000	0.000
61	62	63	64	65
0.000	0.000	0.000	0.000	0.000
66	67	68	69	70
0.000	0.000	0.000	0.000	0.000
71	72	73	74	75
0.000	0.000	0.000	0.000	0.000
76	77	78	79	80
0.000	0.000	0.000	-0.000	-0.000
81	82	83	84	85
-0.000	-0.000	-0.000	-0.000	-0.000
86	87	88	89	90
-0.000	-0.000	-0.000	-0.000	-0.000
91	92	93	94	95
-0.000	-0.000	-0.000	-0.000	-0.000
96	97	98	99	100
-0.000	-0.000	-0.000	-0.000	-0.000
101	102	103	104	105
-0.000	-0.000	-0.000	-0.000	-0.000
106	107	108	109	110

-0.000	-0.000	-0.000	-0.000	-0.000
111	112	113	114	115
-0.000	-0.000	-0.000	-0.000	-0.000
116	117	118	119	120
-0.000	-0.000	-0.000	-0.000	-0.000
121	122	123	124	125
-0.000	-0.000	-0.000	-0.000	-0.000
126	127	128	129	130
-0.000	-0.000	-0.000	-0.000	-0.000
131	132	133	134	135
-0.000	-0.000	-0.000	-0.000	-0.000
136	137	138	139	140
-0.000	-0.000	-0.000	-0.000	-0.000
141	142	143	144	145
-0.000	-0.000	-0.000	-0.000	-0.000
146				
-0.000				

COMPONENT LOADINGS

	1	2	3
COL(1)	0.972	-0.317	0.064
COL(2)	0.998	-0.056	0.024
COL(3)	0.992	0.119	-0.043
COL(4)	0.981	0.189	0.013
COL(5)	0.983	0.167	-0.005
COL(6)	0.991	0.131	0.011
COL(7)	0.812	-0.565	0.109
COL(8)	0.697	-0.710	0.025
COL(9)	0.814	-0.555	0.087
COL(10)	0.968	-0.114	0.067
COL(11)	0.992	0.119	0.019
COL(12)	0.985	0.167	0.007
COL(13)	0.974	0.049	0.036
COL(14)	0.993	-0.051	0.041
COL(15)	0.987	0.012	0.021
COL(16)	0.995	0.043	0.012
COL(17)	0.948	-0.307	0.073

COL(18)	0.892	-0.432	0.094
COL(19)	0.992	0.124	0.012
COL(20)	0.985	0.147	0.021
COL(21)	0.984	0.174	-0.010
COL(22)	0.981	0.189	0.010
COL(23)	0.982	0.183	-0.044
COL(24)	0.997	-0.022	0.040
COL(25)	0.817	-0.558	0.117
COL(26)	0.994	0.108	0.015
COL(27)	0.994	0.101	0.025
COL(28)	0.985	0.163	-0.003
COL(29)	0.995	0.090	0.020
COL(30)	0.992	0.119	0.018
COL(31)	0.982	0.160	0.011
COL(32)	0.819	-0.553	0.116
COL(33)	0.920	-0.371	0.082
COL(34)	0.996	0.080	0.018
COL(35)	0.986	0.152	0.009
COL(36)	0.984	0.161	0.016
COL(37)	0.980	0.190	0.027
COL(38)	0.989	0.123	0.040
COL(39)	0.981	0.191	0.016
COL(40)	0.979	0.198	0.015
COL(41)	0.983	0.180	0.007
COL(42)	0.567	-0.778	0.193
COL(43)	0.995	0.081	0.011
COL(44)	0.880	-0.464	0.103
COL(45)	0.962	-0.253	0.068
COL(46)	0.997	-0.028	0.028
COL(47)	0.998	0.064	0.023
COL(48)	0.995	-0.026	0.027
COL(49)	0.984	0.176	0.013
COL(50)	0.984	0.179	0.011
COL(51)	0.976	0.204	0.011
COL(52)	0.964	0.192	0.040
COL(53)	0.930	-0.353	0.098
COL(54)	0.996	-0.059	0.039
COL(55)	0.997	0.002	-0.062
COL(56)	0.986	0.162	-0.031
COL(57)	0.980	0.194	-0.004
COL(58)	0.989	0.149	-0.012
COL(59)	0.983	0.175	0.001
COL(60)	0.983	0.178	0.005
COL(61)	0.984	0.180	0.001
COL(62)	0.996	0.072	0.013
COL(63)	0.997	-0.021	0.027
COL(64)	0.985	0.173	0.012
COL(65)	0.986	0.168	0.016
COL(66)	0.982	0.190	-0.002
COL(67)	0.983	0.179	0.005
COL(68)	0.986	0.165	0.002
COL(69)	0.967	0.220	0.037
COL(70)	0.983	0.157	0.003
COL(71)	0.965	-0.248	0.067
COL(72)	0.997	-0.055	0.030
COL(73)	0.986	0.166	-0.020
COL(74)	0.971	0.213	0.032
COL(75)	0.984	0.162	-0.063
COL(76)	0.981	0.193	-0.022
COL(77)	0.977	0.206	0.021
COL(78)	0.987	0.122	0.013
COL(79)	0.996	-0.072	0.036
COL(80)	0.996	0.028	0.037
COL(81)	0.983	0.181	-0.008
COL(82)	0.985	0.167	-0.008
COL(83)	[illegible]	0.173	0.018

COL(84)	[illegible]	[illegible]	[illegible]
COL(85)	0.978	0.203	0.022
COL(86)	0.980	0.195	0.011
COL(87)	0.980	0.198	-0.001
COL(88)	0.428	-0.845	0.148
COL(89)	0.841	-0.526	0.125
COL(90)	0.983	0.175	-0.013
COL(91)	0.982	0.180	-0.056
COL(92)	0.988	0.151	-0.034
COL(93)	0.984	0.172	-0.030
COL(94)	0.982	0.186	-0.035
COL(95)	0.983	0.180	-0.019
COL(96)	0.991	0.123	-0.045
COL(97)	0.912	-0.388	-0.084
COL(98)	0.987	0.159	-0.024
COL(99)	0.991	0.067	-0.109
COL(100	0.989	0.134	-0.053
COL(101	0.981	0.193	0.013
COL(102	0.995	-0.071	0.015
COL(103	0.989	0.142	-0.024
COL(104	0.989	0.140	-0.052
COL(105	0.992	0.115	-0.053
COL(106	0.866	-0.489	0.088
COL(107	0.999	0.031	-0.015
COL(108	0.988	-0.021	-0.130
COL(109	0.986	0.147	-0.071
COL(110	0.997	0.068	0.016
COL(111	0.975	0.203	0.020
COL(112	0.980	0.163	-0.063
COL(113	0.623	-0.735	0.176
COL(114	0.991	0.025	-0.116
COL(115	0.994	0.073	-0.060
COL(116	0.992	-0.112	0.003
COL(117	0.748	-0.654	0.111
COL(118	0.998	0.058	0.004
COL(119	0.981	0.002	-0.182
COL(120	0.978	0.200	0.017
COL(121	0.982	[illegible]	[illegible]
COL(122	0.983	0.171	[illegible]
COL(123	0.998	-0.002	-0.048
COL(124	0.769	[illegible]	[illegible]
COL(125	0.862	-0.495	[illegible]
COL(126	0.896	[illegible]	[illegible]
COL(127	0.981	-0.180	[illegible]
COL(128	0.988	[illegible]	[illegible]
COL(129	0.985	-0.168	[illegible]
COL(130	[illegible]	[illegible]	[illegible]
COL(131	0.994	0.110	0.000
COL(132	0.998	-0.030	[illegible]
COL(133	0.994	0.105	0.015
COL(134	0.909	-0.103	0.067
COL(135	0.870	-0.488	0.066
COL(136	0.982	-0.171	-0.073
COL(137	0.907	0.249	0.092
COL(138	0.449	-0.393	-0.752
COL(139	0.279	-0.658	-0.666
COL(140	0.356	-0.101	-0.675
COL(141	0.526	-0.847	-0.010
COL(142	0.537	-0.808	-0.228
COL(143	0.975	0.040	-0.087
COL(144	0.919	-0.230	-0.305
COL(145	0.759	-0.575	-0.276
COL(146	0.845	-0.504	-0.110

VARIANCE EXPLAINED BY COMPONENTS

1	2	3
130.568	11.850	2.474

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3
89.430	8.116	1.695

ROTATED LOADINGS

	1	2	3
COL(1)	0.745	0.661	0.059
COL(2)	0.845	0.528	0.078
COL(3)	0.924	0.362	0.118
COL(4)	0.950	0.306	0.052
COL(5)	0.940	0.323	0.073
COL(6)	0.931	0.361	0.063
COL(7)	0.438	0.893	0.050
COL(8)	0.265	0.949	0.143
COL(9)	0.443	0.881	0.071
COL(10)	0.787	0.579	0.042
COL(11)	0.925	0.373	0.057
COL(12)	0.943	0.326	0.062
COL(13)	0.876	0.429	0.047
COL(14)	0.844	0.524	0.060
COL(15)	0.869	0.463	0.070
COL(16)	0.891	0.439	0.075
COL(17)	0.681	0.729	0.061
COL(18)	[illegible]	0.814	0.053
COL(19)	0.928	0.368	0.063
COL(20)	0.933	0.346	[illegible]
COL(21)	0.945	0.317	0.077
COL(22)	0.949	0.306	0.055
COL(23)	0.947	0.302	0.104
COL(24)	0.862	0.501	0.058
COL(25)	0.445	0.890	0.042
COL(26)	0.921	0.383	0.063
COL(27)	0.919	0.391	0.054
COL(28)	0.940	0.328	0.071
COL(29)	0.914	0.400	0.060
COL(30)	0.926	0.373	0.058
COL(31)	0.937	0.332	0.058
COL(32)	0.449	0.887	0.042
COL(33)	0.625	0.772	0.059
COL(34)	0.910	0.408	0.063
COL(35)	0.936	0.340	0.061
COL(36)	0.939	0.333	0.053
COL(37)	0.949	0.307	0.037
COL(38)	0.925	0.371	0.035
COL(39)	0.951	0.306	0.049
COL(40)	0.952	0.298	0.048
COL(41)	0.947	0.314	0.059
COL(42)	0.120	0.974	-0.025
COL(43)	0.909	0.405	0.071
COL(44)	0.545	0.837	0.047
COL(45)	0.719	0.688	0.059
COL(46)	[illegible]	[illegible]	[illegible]

COL(4[illegible])	[illegible]	[illegible]	[illegible]
COL(48)	0.858	0.502	0.070
COL(49)	0.946	0.319	0.054
COL(50)	0.947	0.316	0.055
COL(51)	0.952	0.291	0.051
COL(52)	0.936	0.300	0.023
COL(53)	0.643	0.764	0.042
COL(54)	0.842	0.532	0.063
COL(55)	0.872	0.462	0.154
COL(56)	0.941	0.324	0.099
COL(57)	0.951	0.299	0.067
COL(58)	0.937	0.340	0.082
COL(59)	0.945	0.317	0.066
COL(60)	0.946	0.316	0.062
COL(61)	0.947	0.313	0.065
COL(62)	0.906	0.415	0.070
COL(63)	0.862	0.498	0.070
COL(64)	0.945	0.322	0.055
COL(65)	0.943	0.328	0.052
COL(66)	0.951	0.303	0.066
COL(67)	0.947	0.314	0.062
COL(68)	0.942	0.328	0.066
COL(69)	0.953	0.277	0.023
COL(70)	0.935	0.333	0.066
COL(71)	0.724	0.685	0.061
COL(72)	0.846	0.527	0.072
COL(73)	0.942	0.323	0.088
COL(74)	0.952	0.284	0.029
COL(75)	0.938	0.318	0.131
COL(76)	0.951	0.297	0.086
COL(77)	0.955	0.291	0.041
COL(78)	0.923	0.367	0.062
COL(79)	0.837	0.543	0.068
COL(80)	0.885	0.457	0.053
COL(81)	0.947	0.311	0.074
COL(82)	0.942	0.314	0.076
COL(83)	0.950	0.303	0.046
COL(84)	0.951	0.295	0.044
COL(85)	0.954	0.294	0.041
COL(86)	0.952	0.300	0.053
COL(87)	0.953	0.293	0.064
COL(88)	-0.034	0.958	0.016
COL(89)	0.482	0.676	0.032
COL(90)	0.945	0.315	0.079
COL(91)	0.945	0.303	0.121
COL(92)	0.936	0.334	0.104
COL(93)	0.944	0.313	0.096
COL(94)	0.948	0.301	0.099
COL(95)	0.947	0.310	0.085
COL(96)	0.925	0.358	0.119
COL(97)	0.608	0.754	0.224
COL(98)	0.939	0.329	0.093
COL(99)	0.898	0.395	0.190
COL(100	0.930	0.346	0.125
COL(101	0.951	0.303	0.051
COL(102	0.836	0.538	0.088
COL(103	0.933	0.344	0.096
COL(104	0.932	0.341	0.124
COL(105	0.922	0.364	0.129
COL(106	0.521	0.849	0.066
COL(107	0.888	0.447	0.103
COL(108	0.852	0.466	0.223
COL(109	0.933	0.330	0.141
COL(110	0.905	0.419	0.067
COL(111	0.951	0.293	0.042
COL(112	[illegible]	[illegible]	0.128

COL(113	0.190	0.780	-0.009
COL(114	0.877	0.431	0.204
COL(115	0.904	0.400	0.141
COL(116	0.813	0.570	0.106
COL(117	0.338	0.939	0.055
COL(118	0.900	0.426	0.081
COL(119	0.856	0.434	0.271
COL(120	0.952	0.296	0.046
COL(121	0.948	0.301	0.106
COL(122	0.942	0.323	0.058
COL(123	0.871	0.468	0.141
COL(124	0.372	0.927	0.028
COL(125	0.515	0.855	0.055
COL(126	0.581	0.802	0.064
COL(127	0.768	0.631	0.095
COL(128	0.921	0.369	0.076
COL(129	0.781	0.617	0.083
COL(130	0.893	0.444	0.045
COL(131	0.922	0.379	0.077
COL(132	0.859	0.508	0.060
COL(133	0.920	0.385	0.063
COL(134	0.600	0.795	0.058
COL(135	0.524	0.846	0.087
COL(136	0.775	0.602	0.188
COL(137	0.915	0.233	-0.041
COL(138	0.193	0.423	0.840
COL(139	-0.084	0.585	0.778
COL(140	0.252	0.106	0.910
COL(141	0.050	0.980	0.182
COL(142	0.075	0.913	0.391
COL(143	0.888	0.424	0.173
COL(144	0.688	0.584	0.419
COL(145	0.382	0.810	0.426
COL(146	0.493	0.818	0.260

VARIANCE EXPLAINED BY ROTATED COMPONENTS

1	2	3
102.597	38.503	3.793

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3
70.272	26.372	2.598

K-means Cluster Analysis (215 samples: Huang data)

SUMMARY STATISTICS FOR 8 CLUSTERS

VARIABLE	BETWEEN SS	DF	WITHIN SS	DF	F-RATIO	PROB
GRAVEL	6492.560	7	3554.102	207	54.021	0.000
SAND	32066.746	7	5156.104	207	183.922	0.000
SILT	10041.188	7	2550.668	207	116.414	0.000
CLAY	1819.253	7	708.6[illegible]	207	75.914	0.000
MEANGS	102.657	7	57.646	207	52.432	0.000
STDDEV	52.047	7	27.455	207	56.070	0.000
SKEW	19.548	7	67.[illegible]52	207	8.552	0.000
KURT	5663.493	7	2487.310	207	67.333	0.000
INORGC	116099.864	7	11339.358	207	302.772	0.000
ORGCARB	32.971	7	30.599	207	31.864	0.000
ORGNIT	0.160	7	0.356	207	13.310	0.000
PHOSP	100.241	7	255.211	207	11.613	0.000

CLUSTER NUMBER: 1

MEMBERS | STATISTICS

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV
8	5.94	GRAVEL	0.00	4.12	20.18	5.[illegible]
11	2.70	SAND	75.88	88.01	99.85	6.3
13	4.14	SILT	0.00	5.74	16.16	4.[illegible]
16	4.87	CLAY	0.00	2.04	9.63	2.1
18	5.24	MEANGS	1.15	2.69	3.84	0.7
19	3.55	STDDEV	0.62	1.67	2.43	0.[illegible]
32	5.39	SKEW	-1.59	0.22	1.60	0.[illegible]
51	2.69	KURT	-0.82	3.39	12.85	3.1
52	3.41	INORGC	1.09	16.57	33.30	7.[illegible]
53	1.99	ORGCARB	0.18	0.75	1.74	0.4
57	5.24	ORGNIT	0.01	0.06	0.15	0.[illegible]
64	2.37	PHOSP	0.00	1.92	4.98	1.[illegible]
65	2.00					

71	[illegible]
79	5.90
82	5.18
83	2.82
84	3.66
85	2.26
93	2.39
115	4.29
117	4.21
123	2.87
124	1.64
132	3.86
141	3.31
148	3.27
149	4.25
168	2.85
171	2.14
176	1.91
177	3.36
183	3.36
184	2.19
185	3.75
188	4.98
192	1.13
196	4.70
198	5.11
199	3.14
201	2.70
205	4.58
212	2.32

CLUSTER NUMBER: 2

MEMBERS | STATISTICS

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV
56	4.54	GRAVEL	[illegible]	.31	[illegible]	4.1
66	4.31	SAND	[illegible]	[illegible]	97.57	5.7
67	[illegible].51	SILT	[illegible]	[illegible]	11.08	2.5
68	4.84	CLAY	[illegible]	0.53	2.54	0.6
69	4.33	MEANGS	[illegible]	1.09	2.69	0.5
70	6.93	STDDEV	[illegible]	1.71	2.56	0.3
76	6.40	SKEW	[illegible]	[illegible]	1.03	0.4
78	7.41	KURT	[illegible]	[illegible]	5.84	1.5
86	4.64	INORGC	[illegible]	[illegible]	[illegible]	14.4
87	2.75	ORGCARB	[illegible]	[illegible]	1.85	0.4
94	6.23	ORGNIT	0.02	[illegible]	0.10	0.0
101	6.70	PHOSP	0.14	1.88	7.12	1.3
102	2.81					
113	2.80					
114	5.88					
122	4.03					
140	6.29					
156	3.66					
175	1.66					
194	2.02					
195	2.98					
203	1.36					
204	2.42					

CLUSTER NUMBER: 3

MEMBERS | STATISTICS

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV
17	5.16	GRAVEL	0.00	6.49	18.86	7.
22	6.21	SAND	46.95	60.20	67.20	6.
25	5.40	SILT	14.47	23.92	33.95	6.
30	4.67	CLAY	4.55	9.39	15.77	3.
166	6.39	MEANGS	2.16	3.80	4.68	0.
213	3.17	STDDEV	1.91	2.63	3.63	0.
214	7.42	SKEW	-0.14	0.17	0.45	0.
215	7.42	KURT	-0.55	-0.15	0.57	0.
		INORGC	2.88	22.07	43.08	16.
		ORGCARB	0.69	1.92	3.06	0.
		ORGNIT	0.07	0.14	0.25	0.
		PHOSP	2.75	4.44	6.37	1.

CLUSTER NUMBER: 4

MEMBERS | STATISTICS

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV
34	3.17	GRAVEL	10.89	28.36	48.60	12.
77	6.23	SAND	41.61	63.08	78.41	12.
111	4.85	SILT	0.00	6.33	17.98	6.
157	8.56	CLAY	0.00	2.23	9.77	3.
182	3.67	MEANGS	-0.84	0.37	1.83	0.
186	4.62	STDDEV	1.64	2.42	3.55	0.
193	5.64	SKEW	-0.13	0.45	0.95	0.
210	6.00	KURT	-0.63	1.11	4.66	1.
		INORGC	81.23	87.22	93.87	4.
		ORGCARB	0.02	1.10	1.81	0.
		ORGNIT	0.04	0.14	0.57	0.1
		PHOSP	0.00	0.57	1.50	0.4

CLUSTER NUMBER: 5

MEMBERS | STATISTICS

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV
207	5.21	GRAVEL	0.06	4.51	13.36	6.2
208	6.37	SAND	23.34	27.05	33.94	4.6
209	7.55	SILT	36.[illegible]	47.26	57.23	8.7
		CLAY	6.72	21.14	28.63	8.
		MEANGS	4.54	5.22	6.[illegible]	0.
		STDDEV	1.[illegible]4	2.64	3.93	0.
		SKEW	-[illegible].29	0.06	0.40	0.
		KURT	-1.19	-0.86	0.19	0.
		INORGC	7.60	25.97	46.77	16.
		ORGCARB	1.93	2.29	2.60	0.
		ORGNIT	0.08	0.12	0.17	0.
		PHOSP	2.85	4.08	6.21	1.

CLUSTER NUMBER: 6

MEMBERS | STATISTICS

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV
2	1.96	GRAVEL	0.00	0.84	7.54	[illegible]
3	1.19	SAND	89.22	95.70	100.00	3.0
4	1.35	SILT	0.00	2.56	7.76	2.
6	1.13	CLAY	0.00	0.91	3.96	0.
9	0.79	MEANGS	1.41	2.78	3.60	0.
12	1.18	STDDEV	0.38	1.12	1.78	0.
14	1.10	SKEW	-1.09	0.46	1.40	0.
15	0.84	KURT	-0.28	7.26	12.58	2.

[illegible]	1.[illegible]	INORGC	[illegible]	[illegible]		[illegible]
23	0.82	ORGCARB	0.04	0.51	1.63	0.
24	1.29	ORGNIT	0.01	0.04	0.13	0.
27	2.82	PHOSP	0.00	1.59	9.03	1.
29	1.46					
31	0.66					
33	1.45					
36	0.93					
38	0.89					
39	0.48					
40	1.29					
41	1.11					
42	1.57					
43	1.49					
44	1.54					
45	1.22					
46	1.26					
47	2.07					
48	1.95					
49	2.24					
50	0.91					
54	1.53					
55	1.45					
56	0.93					
59	2.45					
60	2.34					
61	0.78					
63	1.20					
72	2.12					
73	1.69					
74	2.51					
75	1.22					
80	1.59					
81	1.70					
88	1.54					
90	0.98					
92	1.42					
95	1.83					
96	2.28					
97	1.84					
98	2.38					
99	1.41					
100	2.48					
103	2.31					
104	1.69					
108	1.94					
110	1.69					
112	2.85					
116	2.68					
118	1.37					
119	1.43					
125	1.05					
126	1.69					
127	0.93					
128	1.83					
129	1.72					
130	1.00					
131	2.81					
133	[illegible]					
134	[illegible]					
135	1.25					
136	1.67					
137	0.88					
139	2.75					
142	0.65					
[illegible]	[illegible]					

14[illegible]	[illegible]	
147	2.69	
150	0.80	
151	1.32	
156	1.52	
159	1.66	
160	1.98	
161	1.05	
162	1.16	
163	1.52	
164	0.92	
165	2.36	
167	1.10	
169	2.19	
170	1.86	
172	1.37	
173	1.89	
174	2.25	
178	2.50	
179	2.59	
181	1.94	
187	2.78	
190	1.63	
197	3.02	
200	1.56	
202	1.79	

CLUSTER NUMBER: 7

MEMBERS			STATISTICS				
CASE	DISTANCE		VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DEV
1	1.23		GRAVEL	0.00	0.09	0.95	0.2
5	0.61		SAND	95.39	97.82	99.63	1.1
7	1.35		SILT	0.28	1.55	3.59	0.9
10	0.35		CLAY	0.00	0.53	1.54	0.3
20	2.87		MEANGS	2.13	2.95	3.84	0.3
26	1.67		STDDEV	0.35	0.62	1.11	0.1
28	0.97		SKEW	-0.19	1.12	1.75	0.5
35	1.72		KURT	12.86	18.04	48.36	6.4
37	0.99		INORGC	0.37	2.42	5.97	2.1
62	1.70		ORGCARB	0.13	0.30	0.74	0.1
89	1.52		ORGNIT	0.01	0.03	0.09	0.0
91	1.23		PHOSP	0.00	1.17	2.32	0.7
105	1.20						
106	1.03						
107	2.13						
109	1.53						
120	0.71						
121	2.72						
138	1.28						
143	0.87						
146	1.38						
152	0.63						
153	0.39						
154	1.32						
155	1.57						
180	0.40						
189	0.89						
191	1.19						
206	7.92						

CLUSTER NUMBER: 8

MEMBERS STATISTICS

CASE	DISTANCE	VARIABLE	MINIMUM	MEAN	MAXIMUM	ST.DE
211	0.00	GRAVEL	12.48	12.48	12.48	0.0
		SAND	44.31	44.31	44.31	0.0
		SILT	32.67	32.67	32.67	0.0
		CLAY	10.54	10.54	10.54	0.0
		MEANGS	3.16	3.16	3.16	0.0
		STDDEV	3.45	3.45	3.45	0.0
		SKEW	0.06	0.06	0.06	0.0
		KURT	-1.07	-1.07	-1.07	0.0
		INORGC	74.21	74.21	74.21	0.0
		ORGCARB	2.74	2.74	2.74	0.0
		ORGNIT	0.15	0.15	0.15	0.0
		PHOSP	0.69	0.69	0.69	0.0

SYSTAT PROCESSING FINISHED

INPUT STATEMENTS FOR THIS JOB:

```
USE HUANG
OUTPUT @
KMEANS/NUMBER=8
```

R Mode Factor Analysis

(215 samples, 12 variables: Huang data)

MATRIX TO BE FACTORED

	GRAVEL	SAND	SILT	CLAY	MEANGS
GRAVEL	1.000				
SAND	-0.579	1.000			
SILT	0.063	-0.837	1.000		
CLAY	0.082	-0.800	0.552	1.000	
MEANGS	-0.666	-0.085	0.519	0.502	1.000
STDDEV	0.632	-0.641	0.501	0.620	-0.122
SKEW	-0.301	0.142	0.023	0.011	0.214
KURT	-0.418	0.490	-0.335	-0.248	0.228
INORGC	0.699	-0.471	0.140	0.094	-0.606
ORGCARB	0.201	-0.729	0.755	0.712	0.293
ORGNIT	0.302	-0.531	0.446	0.437	0.023
PHOSP	-0.043	-0.318	0.407	0.396	0.253

	STDDEV	SKEW	KURT	INORGC	ORGCARB
STDDEV	1.000				

SKEW	[illegible]	[illegible]			
KURT	-0.626	0.558	1.000		
INORGC	0.549	-0.262	-0.470	1.000	81
ORGCARB	0.661	-0.017	-0.430	0.280	1.000
ORGNIT	0.512	0.031	-0.289	0.290	0.510
PHOSP	0.279	-0.068	-0.229	-0.067	0.384

	ORGNIT	PHOSP
ORGNIT	1.000	
PHOSP	0.236	1.000

LATENT ROOTS (EIGENVALUES)

1	2	3	4	5
5.246	2.880	1.162	0.755	0.585

6	7	8	9	10
0.430	0.322	0.255	0.165	0.131

11	12
0.068	0.002

COMPONENT LOADINGS

	1	2	3	4
SAND	[illegible]	[illegible]	[illegible]	-0.127
STDDEV	[illegible]	[illegible]	[illegible]	[illegible]
ORGCARB	0.822	[illegible]	[illegible]	[illegible]
SILT	0.807	[illegible]	[illegible]	0.161
CLAY	-0.788	[illegible]	[illegible]	0.162
KURT	-0.645	[illegible]	[illegible]	[illegible]
ORGNIT	0.630	[illegible]	[illegible]	-0.323
GRAVEL	0.325	[illegible]	[illegible]	[illegible]
INORGC	0.319	[illegible]	[illegible]	0.041
MEANGS	0.084	[illegible]	[illegible]	[illegible]
SKEW	-0.227	0.440	[illegible]	[illegible]
PHOSP	0.419	[illegible]	[illegible]	[illegible]

VARIANCE EXPLAINED BY COMPONENTS

1	2	3	4
5.246	2.880	1.162	0.755

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3	4
43.714	24.002	9.686	6.290

ROTATED LOADINGS

	1	2	3	4
SILT	0.939	0.112	0.049	0.123
CLAY	0.921	0.115	0.045	0.116
SAND	-0.880	0.367	-0.132	-0.082
ORGCARB	0.833	-0.101	0.058	0.215
STDDEV	0.711	-0.522	0.227	0.140
ORGNIT	0.519	-0.377	-0.219	0.375
GRAVEL	0.179	-0.885	0.174	-0.037
MEANGS	0.472	0.839	-0.118	0.022
INORGC	0.207	-0.829	0.184	-0.083
SKEW	0.045	0.140	-0.916	-0.006
KURT	-0.348	0.369	-0.699	-0.180
PHOSP	0.265	0.139	0.132	0.902

VARIANCE EXPLAINED BY ROTATED COMPONENTS

1	2	3	4
4.462	[illegible].935	1.549	1.097

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3	4
37.184	24.460	12.908	9.143

FACTOR SCORE COEFFICIENTS

	1	2	3	4
SILT	0.254	0.110	0.018	-0.134
CLAY	0.256	0.110	0.017	0.137
SAND	-0.219	0.074	0.014	0.137
ORGCARB	0.186	0.002	-0.[illegible]2	0.[illegible]3
STDDEV	0.136	-0.134	0.027	-0.016
ORGNIT	0.035	-0.203	-0.314	0.358
GRAVEL	0.001	-0.319	-0.058	-0.042
MEANGS	0.198	0.356	0.072	-0.165
INORGC	0.026	-0.288	-0.034	-0.111
SKEW	0.056	-0.139	-0.697	0.067
KURT	-0.007	-0.006	-0.442	-0.073
PHOSP	-0.171	0.[illegible]	0.029	0.983

SCORES HAVE BEEN SAVED

4.STAT PROCESSING FINISHED

INPUT STATEMENTS FOR THIS JOB:

```
USE HUANG
SORT
ROTATE=VARIMAX
NUMBER=4
OUTPUT @
SAVE HUNASCOR
FACTOR
```

		FACTOR(1)	FACTOR(2)	FACTOR(3)	FACTOR(4)
CASE	1	0.190	-0.013	-2.429	-0.865
CASE	2	0.745	-0.033	-0.676	-0.705
CASE	3	0.216	-0.007	-1.007	-1.003
CASE	4	0.510	0.289	-0.894	-1.025
CASE	5	-0.149	0.039	-2.248	-1.002
CASE	6	-0.053	0.206	-0.891	-1.016
CASE	7	-0.290	-0.215	-2.791	-0.976
CASE	8	1.632	0.606	-0.002	0.387
CASE	9	-0.145	0.347	-0.605	0.891
CASE	10	-0.303	0.363	-1.714	-0.175
CASE	11	0.171	-0.809	0.524	0.344
CASE	12	0.056	-0.111	-1.458	-0.684
CASE	13	-0.656	0.251	-0.292	0.245
CASE	14	0.059	0.097	-0.681	-0.117
CASE	15	0.065	0.261	-0.756	-0.212
CASE	16	0.949	0.523	-0.065	0.875
CASE	17	3.057	0.698	-0.250	3.580
CASE	18	1.302	0.304	-0.321	1.466
CASE	19	0.718	0.208	-0.579	1.736
CASE	20	-0.421	0.223	-1.89[illegible]	-0.625
CASE	21	-0.617	0.337	-0.996	-1.176
CASE	22	2.184	0.571	[illegible].425	3.156
CASE	23	-0.401	0.[illegible]4	-[illegible].221	-0.739
CASE	24	0.107	0.[illegible]79	-[illegible].748	0.154
CASE	25	2.808	1.097	0.173	1.617
CASE	26	-0.563	0.263	[illegible]	-1.197
CASE	27	-0.186	0.[illegible]	1.412	-0.525
CASE	28	-0.276	0.156	-1.446	-0.611
CASE	29	-0.384	0.422	-0.613	0.013
CASE	30	2.407	1.025	[illegible]	[illegible]
CASE	31	-0.092	0.323	-0.265	-1.271
CASE	32	1.066	0.456	0.351	-1.655
CASE	33	-0.706	0.463	0.373	-0.461
CASE	34	0.009	-0.449	-2.716	2.373
CASE	35	-0.019	1.561	-2.408	-0.926
CASE	36	-0.192	0.332	0.462	-0.073
CASE	37	-0.676	0.660	-0.521	-0.400
CASE	38	-0.229	0.327	-0.845	0.498
CASE	39	-0.039	0.354	-0.274	-0.452
CASE	40	-0.303	0.232	-1.012	-0.291
CASE	41	-0.451	0.502	-0.335	-0.062
CASE	42	-0.965	0.696	1.043	0.248
CASE	43	-0.625	0.603	0.957	-0.174
CASE	44	-0.419	0.201	-1.090	-0.103
CASE	45	0.167	0.645	-0.348	0.157
CASE	46	-0.341	0.263	0.040	0.259
CASE	47	0.420	0.392	-0.577	0.544
CASE	48	0.553	0.091	-0.918	-0.366
CASE	49	-0.402	0.988	1.419	-0.716
CASE	50	-0.180	0.322	-0.590	0.724
CASE	51	0.742	0.585	-0.041	-0.633

CASE	52	[illegible]	[illegible]	[illegible]	[illegible]
CASE	53	0.369	0.196	-0.195	-0.491
CASE	54	-0.313	0.372	-0.729	-0.433
CASE	55	-0.677	0.428	0.996	-0.193
CASE	56	-0.628	0.524	0.469	0.633
CASE	57	0.149	-1.270	1.063	-0.912
CASE	58	0.324	-1.899	0.272	-0.045
CASE	59	-0.126	0.443	0.648	0.657
CASE	60	-1.050	0.520	-0.548	5.654
CASE	61	-0.247	0.358	-0.530	-0.313
CASE	62	-0.115	0.581	-0.840	-0.722
CASE	63	-0.539	0.300	-0.555	0.378
CASE	64	0.053	0.221	-0.032	0.898
CASE	65	-0.017	0.052	-0.050	-0.994
CASE	66	-0.292	-1.059	-0.981	0.158
CASE	67	0.233	-0.283	0.422	0.253
CASE	68	0.773	-1.432	0.206	0.680
CASE	69	-1.049	-1.466	-0.064	4.461
CASE	70	-1.043	-1.029	-0.316	3.382
CASE	71	-0.468	-0.136	0.389	0.193
CASE	72	0.172	0.466	0.153	0.301
CASE	73	-0.618	0.350	-0.100	-0.568
CASE	74	-0.948	0.631	1.298	0.402
CASE	75	-0.566	0.491	0.400	-0.165
CASE	76	-0.155	-1.229	0.991	-1.429
CASE	77	1.016	-2.286	-0.366	-1.200
CASE	78	-0.100	-1.379	-0.287	-0.693
CASE	79	-0.258	-1.403	1.338	-0.785
CASE	80	-0.644	0.593	2.009	-0.022
CASE	81	-0.914	0.624	0.552	0.012
CASE	82	-0.756	-1.190	1.125	0.025
CASE	83	-1.056	-0.958	0.682	2.935
CASE	84	-0.229	-1.016	[illegible]	-0.263
CASE	85	-0.740	-0.339	1.081	2.020
CASE	86	-0.430	-0.945	0.981	-0.683
CASE	87	-0.662	-0.809	1.557	-0.695
CASE	88	-0.343	[illegible]	1.001	-0.166
CASE	89	-0.342	0.172	1.014	0.404
CASE	90	-0.251	0.513	-0.549	-0.363
CASE	91	-0.485	0.349	-1.206	0.183
CASE	92	-0.188	0.314	0.395	0.844
CASE	93	-0.436	[illegible]	0.901	-0.863
CASE	94	-0.965	-1.296	[illegible]	-0.138
CASE	95	-0.721	0.511	0.801	0.378
CASE	96	-0.722	0.360	0.265	0.194
CASE	97	-0.739	0.61[illegible]	0.218	-0.066
CASE	98	-0.701	[illegible]	1.705	[illegible]
CASE	99	-0.613	[illegible]	0.844	-0.612
CASE	100	-0.962	-0.165	1.679	0.350
CASE	101	-0.857	-1.416	1.722	0.267
CASE	102	-0.516	-0.894	0.601	0.915
CASE	103	-0.662	0.246	1.464	-0.196
CASE	104	-0.479	0.276	1.595	-0.576
CASE	105	-0.334	0.309	-1.402	-0.472
CASE	106	-0.701	0.663	-0.275	0.110
CASE	107	-0.726	0.400	0.132	-0.450
CASE	108	-0.590	0.708	0.002	-0.678
CASE	109	-0.242	0.891	-0.718	-0.630
CASE	110	-0.643	0.659	0.493	-0.150
CASE	111	-0.238	-1.263	0.478	-1.464
CASE	112	-0.986	0.403	1.449	-0.137
CASE	113	-0.103	-1.547	0.967	-0.735
CASE	114	-0.515	-0.123	0.435	-0.790
CASE	115	-0.956	0.247	1.335	0.156
CASE	116	-0.610	0.427	1.250	-0.434
CASE	117	[illegible]	[illegible]	1.645	[illegible]

CASE	118	[illegible]	[illegible]	[illegible]	[illegible]
CASE	119	-0.369	0.403	-0.151	-0.796
CASE	120	-0.447	0.342	-1.720	0.163
CASE	121	-0.360	0.657	-2.219	0.005
CASE	122	-0.949	-1.456	0.862	0.545
CASE	123	-0.714	-0.348	1.386	0.044
CASE	124	0.544	0.361	-0.482	-0.151
CASE	125	0.027	0.331	-0.707	1.133
CASE	126	-0.296	0.336	-0.987	-0.040
CASE	127	-0.331	0.233	-0.383	1.218
CASE	128	-0.728	0.663	0.819	-0.205
CASE	129	-1.007	0.430	0.363	0.715
CASE	130	-0.523	0.360	0.056	-0.114
CASE	131	-0.638	0.558	1.021	-0.440
CASE	132	-0.693	0.353	1.756	-0.189
CASE	133	-0.632	0.426	0.041	-0.796
CASE	134	-0.711	0.596	0.979	-0.155
CASE	135	-0.406	0.342	-0.410	-0.539
CASE	136	-0.943	0.350	0.220	0.147
CASE	137	-0.512	0.628	0.209	-0.260
CASE	138	-0.633	0.402	-1.976	0.426
CASE	139	-0.542	-0.390	0.805	0.784
CASE	140	-0.366	-0.538	1.353	0.211
CASE	141	-0.429	0.030	1.010	0.293
CASE	142	-0.175	0.511	0.087	-0.201
CASE	143	-0.408	0.463	-1.332	-1.372
CASE	144	0.260	0.365	-0.429	2.026
CASE	145	-0.092	0.274	-0.877	0.645
CASE	146	-0.735	0.350	-0.912	-0.009
CASE	147	-0.993	-0.149	1.731	0.443
CASE	148	-0.517	0.067	1.178	-0.091
CASE	149	-0.495	[illegible]	-1:159	0.348
CASE	150	-0.428	0.459	-0.243	0.209
CASE	151	-0.202	0.641	-0.357	0.160
CASE	152	-0.523	0.559	-1.109	-0.194
CASE	153	-0.427	0.725	-0.886	-0.485
CASE	154	-0.683	0.678	-0.526	-0.451
CASE	155	-0.490	0.683	[illegible]	-0.413
CASE	156	-0.351	[illegible]	-1.014	-0.325
CASE	157	0.957	-4.675	[illegible]	-1.476
CASE	158	-0.372	-1.706	1.391	-0.478
CASE	159	-0.269	0.687	-0.356	0.501
CASE	160	0.299	[illegible]	0.788	0.306
CASE	161	-0.150	0.330	[illegible]	0.521
CASE	162	0.080	[illegible]	[illegible]	[illegible]
CASE	163	0.281	0.542	-0.306	[illegible]
CASE	164	-0.106	0.249	-0.665	0.115
CASE	165	0.502	0.136	-0.159	0.395
CASE	166	1.017	-1.204	[illegible]	0.594
CASE	167	0.197	0.480	0.806	-0.859
CASE	168	0.623	0.501	-0.032	0.097
CASE	169	0.365	0.675	-0.443	0.591
CASE	170	-0.614	0.564	-0.411	-0.447
CASE	171	-0.072	-0.315	1.283	-0.013
CASE	172	-0.030	0.362	0.487	0.285
CASE	173	0.218	0.354	-0.214	-0.210
CASE	174	0.292	0.476	-0.404	0.233
CASE	175	0.333	-1.605	0.136	0.448
CASE	176	0.268	0.247	-0.000	-1.048
CASE	177	0.521	0.372	0.913	0.093
CASE	178	0.510	0.478	-0.178	-0.382
CASE	179	-0.480	0.300	0.346	0.054
CASE	180	-0.381	0.441	-1.211	-0.919
CASE	181	0.066	0.591	0.040	0.967
CASE	182	0.442	-4.166	-1.424	-0.493
CASE	183	1.309	0.333	0.256	0.376

CASE	184	[illegible]	[illegible]	[illegible]	[illegible]
CASE	185	0.041	0.058	0.453	0.021
CASE	186	0.459	-2.618	-0.746	0.141
CASE	187	-0.232	0.295	0.731	-0.929
CASE	188	0.836	0.314	0.342	1.795
CASE	189	-0.579	0.716	-0.766	0.212
CASE	190	0.086	0.678	-0.411	0.257
CASE	191	-0.169	0.525	-1.273	-0.245
CASE	192	0.536	0.075	0.926	-0.157
CASE	193	0.156	-2.846	-0.679	-0.232
CASE	194	0.181	-1.441	0.805	-0.719
CASE	195	-0.122	-0.509	0.490	-0.980
CASE	196	0.147	-1.142	0.196	-0.076
CASE	197	0.097	-0.135	1.131	-0.860
CASE	198	-0.073	-0.289	0.645	-0.502
CASE	199	-0.352	0.545	2.211	-1.147
CASE	200	-0.340	0.545	0.647	-0.116
CASE	201	-0.321	0.120	1.751	-0.805
CASE	202	-0.614	0.704	1.365	-0.067
CASE	203	-0.226	-0.875	1.000	-0.158
CASE	204	0.423	-1.973	0.061	0.470
CASE	205	1.047	0.101	0.715	0.035
CASE	206	-0.635	0.661	2.892	-0.197
CASE	207	4.173	1.547	0.660	-1.155
CASE	208	5.456	2.075	1.132	-1.806
CASE	209	3.065	0.523	0.394	1.721
CASE	210	2.752	-2.619	-0.101	-2.027
CASE	211	3.682	-1.196	0.296	-1.773
CASE	212	0.921	0.720	-0.401	-1.014
CASE	213	2.363	0.601	0.243	0.089
CASE	214	3.178	-0.511	0.705	0.522
CASE	215	1.807	-1.515	0.572	0.451

SYSTAT PROCESSING FINISHED

INPUT STATEMENTS FOR THIS JOB:

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USE HUNASCOR
OUTPUT @
LIST
RUN
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LATENT ROOTS (EIGENVALUES)

Q Mode Factor Analysis

(71 samples: Pierce et al/Estevez data)

1	2	3	4	5
45.174	16.986	5.685	1.024	0.130
6	7	8	9	10
0.000	0.000	0.000	0.000	0.000
11	12	13	14	15
0.000	0.000	0.000	0.000	0.000
16	17	18	19	20
0.000	0.000	0.000	0.000	0.000
21	22	23	24	25
0.000	0.000	0.000	0.000	0.000
26	27	28	29	30
0.000	0.000	0.000	0.000	0.000
31	32	33	34	35
0.000	0.000	0.000	0.000	0.000
36	37	38	39	40
0.000	-0.000	-0.000	-0.000	-0.000
41	42	43	44	45
-0.000	-0.000	-0.000	-0.000	-0.000
46	47	48	49	50
-0.000	-0.000	-0.000	-0.000	-0.000
51	52	53	54	55
-0.000	-0.000	-0.000	-0.000	-0.000
56	57	58	59	60
-0.000	-0.000	-0.000	-0.000	-0.000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

-0.000	-0.000	-0.000	-0.000	-0.000
66	67	68	69	70
-0.000	-0.000	-0.000	-0.000	-0.000
71				
-0.000				

COMPONENT LOADINGS

	1	2	3
COL(60)	0.991	0.083	-0.098
COL(59)	0.991	0.105	0.022
COL(18)	0.989	0.127	0.059
COL(9)	0.987	-0.158	0.003
COL(2)	0.982	0.098	0.149
COL(68)	0.979	0.101	0.127
COL(28)	0.977	0.196	0.063
COL(27)	0.971	-0.174	0.062
COL(4)	0.969	0.231	0.023
COL(17)	0.967	-0.130	0.172
COL(41)	0.955	0.291	0.048
COL(63)	0.954	-0.262	0.097
COL(70)	0.950	-0.282	0.126
COL(56)	0.948	-0.271	0.017
COL(36)	0.947	-0.235	0.149
COL(34)	0.943	0.312	0.087
COL(44)	0.941	0.156	-0.065
COL(25)	0.938	0.337	0.017
COL(69)	0.931	-0.322	0.098
COL(42)	0.916	0.376	-0.135
COL(14)	0.915	0.386	0.101
COL(32)	0.910	-0.271	-0.160
COL(52)	0.899	-0.422	0.058
COL(55)	0.895	-0.408	0.038
COL(1)	0.894	-0.386	-0.155
COL(23)	0.869	0.450	-0.080
COL(29)	0.871	0.462	0.090
COL(39)	0.866	-0.491	-0.066
COL(71)	0.866	0.259	-0.375
COL(10)	0.865	-0.494	-0.027
COL(24)	0.862	0.295	-0.362
COL(8)	0.856	-0.226	-0.347
COL(67)	0.850	-0.523	-0.031
COL(20)	0.845	0.526	0.087
COL(37)	0.833	-0.511	0.123
COL(12)	0.824	-0.558	0.050
COL(62)	0.813	-0.579	-0.039
COL(16)	0.807	0.581	0.106
COL(11)	0.792	0.606	0.063
COL(53)	0.791	-0.605	0.029
COL(7)	0.787	0.615	0.058
COL(58)	0.786	-0.605	0.035
COL(31)	0.776	0.507	-0.328
COL(47)	0.749	0.662	0.024
COL(61)	0.733	-0.673	0.072
COL(43)	0.732	0.670	0.119
COL(22)	0.730	0.675	0.107

COL(57)	0.[illegible]	[illegible]	
COL(30)	0.728	-0.680	-0.065
COL(66)	0.722	-0.661	0.113
COL(51)	0.719	-0.680	-0.141
COL(13)	0.716	-0.690	-0.015
COL(50)	0.713	0.694	0.101
COL(33)	0.705	-0.700	0.027
COL(45)	0.701	-0.688	0.082
COL(49)	0.684	-0.721	0.016
COL(15)	0.677	0.730	0.095
COL(48)	0.669	-0.723	0.043
COL(3)	0.659	0.747	-0.039
COL(6)	0.646	0.756	0.109
COL(21)	0.638	0.762	0.111
COL(5)	0.543	0.835	0.083
COL(38)	0.452	0.890	0.055
COL(40)	0.466	0.884	0.031
COL(26)	0.463	0.883	0.070
COL(19)	0.234	0.554	-0.791
COL(46)	0.172	-0.185	-0.948
COL(54)	0.325	0.039	-0.941
COL(35)	0.043	0.282	-0.925
COL(65)	0.132	-0.386	-0.909
COL(64)	-0.288	0.294	-0.795

VARIANCE EXPLAINED BY COMPONENTS

1	2	3
45.174	18.986	5.686

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3
63.626	26.741	8.007

ROTATED LOADINGS

	1	2	3
COL(61)	0.996	-0.006	-0.049
COL(30)	0.994	-0.026	0.067
COL(13)	0.993	-0.037	0.036
COL(53)	0.993	0.079	0.001
COL(33)	0.993	-0.049	-0.006
COL(49)	0.991	-0.079	0.001
COL(62)	0.990	0.107	0.071
COL(57)	0.989	-0.024	0.142
COL(58)	0.989	0.077	-0.006
COL(12)	0.987	0.138	-0.016
COL(51)	0.986	-0.038	0.162
COL(45)	0.983	-0.037	-0.062
COL(48)	0.982	-0.088	-0.027
COL(66)	0.981	-0.002	-0.091
COL(67)	0.981	0.174	0.069
COL(10)	0.973	0.206	0.067
COL(39)	0.972	0.211	0.046
COL(37)	0.963	0.165	-0.086
COL([illegible])	[illegible]	[illegible]	-0.013

COL(55)	[illegible]	[illegible]	[illegible]
COL(1)	0.919	0.295	0.202
COL(69)	0.909	0.388	-0.045
COL(63)	0.900	0.433	-0.041
COL(56)	0.899	0.413	0.071
COL(70)	0.898	0.433	-0.070
COL(36)	0.864	0.467	-0.091
COL(32)	0.853	0.391	0.212
COL(27)	0.839	0.521	0.000
COL(9)	0.839	0.540	0.060
COL(17)	0.809	0.561	-0.108
COL(8)	0.787	0.365	0.397
COL(60)	0.679	0.713	0.172
COL(2)	0.667	0.738	-0.073
COL(59)	0.667	0.739	0.054
COL(68)	0.663	0.737	-0.052
COL(18)	0.651	0.757	0.017
COL(28)	0.596	0.800	0.016
COL(44)	0.594	0.736	0.139
COL(4)	0.566	0.818	0.057
COL(41)	0.516	0.856	0.033
COL(15)	0.018	1.000	-0.013
COL(6)	-0.022	0.999	-0.029
COL(21)	-0.033	0.999	-0.031
COL(50)	0.068	0.997	-0.018
COL(22)	0.094	0.995	-0.025
COL(43)	0.099	0.994	-0.036
COL(47)	0.114	0.992	0.059
COL(3)	-0.011	0.990	0.119
COL(5)	-0.153	0.988	-0.007
COL(7)	0.175	0.984	0.026
COL(11)	0.185	0.982	0.021
COL(16)	0.214	0.976	-0.022
COL(26)	-0.245	0.969	0.002
COL(40)	-0.244	0.969	0.041
COL(38)	-0.258	0.966	0.017
COL(20)	0.278	0.960	-0.002
COL(29)	0.327	0.944	-0.005
COL(23)	0.358	0.919	0.164
COL(14)	0.424	0.904	-0.016
COL(42)	0.426	0.878	0.217
COL(25)	0.472	0.876	0.065
COL(31)	0.229	0.866	[illegible]
COL(34)	0.494	0.866	[illegible]
COL(24)	0.435	0.763	[illegible]
COL(71)	0.461	0.738	0.446
COL(19)	-0.215	0.503	0.830
COL(54)	0.193	0.168	0.763
COL(46)	0.229	-0.099	0.949
COL(35)	-0.179	0.163	0.937
COL(65)	0.334	-0.272	0.898
COL(64)	-0.430	-0.037	0.784

VARIANCE EXPLAINED BY ROTATED COMPONENTS

1	2	3
33.445	30.486	5.914

PERCENT OF TOTAL VARIANCE EXPLAINED

1	2	3

	47.106	42.938	8.329

FACTOR SCORE COEFFICIENTS

	1	2	3
COL(61)	0.036	-0.014	-0.013
COL(30)	0.036	-0.017	0.011
COL(13)	0.036	-0.017	0.002
COL(53)	0.034	-0.012	-0.005
COL(33)	0.036	-0.017	-0.005
COL(49)	0.037	-0.018	-0.003
COL(62)	0.034	-0.011	0.007
COL(57)	0.035	-0.017	0.021
COL(58)	0.034	-0.012	-0.006
COL(12)	0.033	-0.009	-0.009
COL(51)	0.035	-0.018	0.024
COL(45)	0.036	-0.015	-0.015
COL(48)	0.037	-0.018	-0.008
COL(66)	0.036	-0.014	-0.020
COL(67)	0.032	-0.008	0.006
COL(10)	0.032	-0.007	0.005
COL(39)	0.032	-0.007	0.001
COL(37)	0.032	-0.006	-0.021
COL(52)	0.030	-0.002	-0.010
COL(55)	0.029	-0.002	-0.006
COL(1)	0.028	-0.004	0.028
COL(69)	0.027	0.003	-0.016
COL(63)	0.026	0.004	-0.016
COL(56)	0.026	0.002	0.004
COL(70)	0.026	0.005	-0.021
COL(36)	0.024	0.007	[illegible]
COL(32)	0.024	0.001	0.029
COL(27)	0.022	0.008	-0.010
COL(9)	0.022	0.008	0.001
COL(17)	0.021	0.012	-0.029
COL(8)	0.021	[illegible]	[illegible]
COL(60)	0.013	0.016	[illegible]
COL(2)	0.013	0.020	-0.024
COL(59)	0.013	[illegible]	-0.002
COL(68)	0.013	0.020	-0.020
COL(18)	0.012	0.020	-0.009
COL(28)	0.009	0.023	-0.009
COL(44)	0.010	0.019	0.013
COL(4)	0.008	0.024	-0.002
COL(41)	0.006	0.026	-0.006
COL(15)	-0.014	0.040	-0.014
COL(6)	-0.016	0.041	-0.015
COL(21)	-0.016	0.041	-0.017
COL(50)	-0.012	0.039	-0.015
COL(22)	-0.011	0.039	-0.016
COL(43)	-0.011	0.039	-0.018
COL(47)	-0.011	0.037	-0.001
COL(3)	-0.016	0.038	0.010
COL(5)	-0.020	0.042	-0.012
COL(7)	-0.008	0.036	-0.008
COL(11)	-0.008	0.036	-0.008
COL(16)	-0.007	0.036	-0.016
COL(26)	-0.023	0.042	-0.010
[illegible]	[illegible]	[illegible]	[illegible]

COL(38)	-0.024	0.042	-0.007
COL(20)	-0.004	0.034	-0.013
COL(29)	-0.002	0.033	-0.013
COL(23)	-0.002	0.030	0.017
COL(14)	0.002	0.030	-0.015
COL(42)	0.001	0.026	0.026
COL(25)	0.004	0.027	-0.001
COL(31)	-0.006	0.027	0.060
COL(34)	0.005	0.027	-0.013
COL(24)	0.002	0.019	0.065
COL(71)	0.004	0.018	0.068
COL(19)	-0.019	0.014	0.140
COL(54)	0.000	-0.007	0.166
COL(46)	0.005	-0.018	0.166
COL(35)	-0.013	-0.001	0.163
COL(65)	0.012	-0.026	0.159
COL(64)	-0.018	-0.004	0.140